MATHEMATICAL COMMUNICATION ABILITY OF JUNIOR HIGH SCHOOL STUDENTS AND MATHEMATICAL COMMUNICATION SELF-EFFICACY

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Abstract

Mathematical communication is one of the mathematical abilities based on National Council of Teachers of Mathematics and obtaining this ability is also one purpose of learning mathematics. All of students in junior high school must have the mathematical communication ability. In addition, the students also need belief in their capability to reach the high mathematics achievement. Their judgment of this belief is called as self-efficacy. Generally, there was a positive relation between mathematical performance and mathematical self-efficacy. A study was conducted to investigate whether or not there was a significant different between mathematical communication ability of junior high school student according to their mathematical communication self-efficacy levels. The data were collected through instrument tests which were Mathematical Communication Ability (MCA) test and Mathematical Communication Self-Efficacy (MCSE) scale. The mathematical communication test consists of five questions about linear equations in one variable and social arithmetic. Both of instruments have good validity and reliability. The participant was 32 seventh grade students in Subang, West Java, Indonesia. Score of students in both instruments was analyzed as research data. Data are analyzed by using one-way Analysis of Variance (Anova) after testing the data normality. The result showed that there was a significant difference between the mathematical communication ability (MCA) of the junior high school student with low mathematical communication self-efficacy (MCSE) level and the student with middle and high MCSE level. In detail, the study showed the students' MCA with high and middle MCSE level is better than students' MCA with low MCSE level.

Keywords: junior high school, mathematical communication, self-efficacy

1 INTRODUCTION

Mathematics is one of the subjects taught from basic education level to higher education. In Curriculum 2013, Indonesia's Curriculum, the aim of mathematics learning for the students is to improve their mathematics skill i.e. reasoning, communication, and problem solving. After learning mathematics, the students should have the following competencies. They are (1) understanding concepts and applying mathematical procedure in daily life; (2) generalizing based on pattern, fact, phenomenon, or data; (3) doing mathematical operating to simplify and analyze the given component; (4) doing mathematical reasoning included both conjecturing and verifying; (5) Solving the problems and communicating the idea through symbol, table, diagram, or the other media to make clear the given situation or problems; and (6) improving the positive attitude such as logical, critical, accurate, careful, and never give up in solving the problems, understanding mathematical concepts, explaining the relationship between the concepts and applying concepts or algorithm (Regulation of Education and Culture Ministry Number 21, 2016 on Content Standard of Elementary and Secondary Education). From the previous explanation, it can indicate that the goal of learning mathematics is not only for solving mathematics problems mechanically but also solving complex

problems. Point 1 to 5 is about cognitive skills, meanwhile point 6 is head for affective skill in learning and solving mathematics problems.

Mathematical communication is one of the abilities that must be improved during mathematics learning. In standard for school mathematics, NCTM (2000) stated that mathematical communication is an important part in mathematics and mathematics education. Sumarmo and Nishitani (2010) said that Mathematical Communication Ability (MCA) is an ability to explain and illustrate mathematics ideas into model of mathematics or vice versa. The model can be equations, inequality, notations, picture or graph. The students which is has MCA can transform mathematics problems in daily life to the mathematics model and also can transform mathematics model into daily life situation. In addition, through the communication process, students learn to be clear and convincing in presenting their mathematical ideas, which definitely help develop their logical thinking.

In solving mathematics problems, the students is not only need cognitive ability but also affective ability like belief or conviction in their self to achieve a goal. This belief is called as self-efficacy. Bandura (1977) defined self-efficacy as a self-judgmental of ability to complete a task. Someone with the strength self-efficacy will see a problem as a challenge and they will put the best effort to solve it. On the contrary, people with weak self-efficacy will avoid the challenge problems and easy to give up in complete their task (Bandura, 1994). Since mathematics is a challenge subject then self-efficacy is needed in solving the mathematics problems. A research showed that there was a strength positive relationship between mathematics self-efficacy and mathematics performance (Hacket & Betz, 2000; Soleymani & Rekabdar, 2016). It means that the students with strength self-efficacy will success in learning mathematics.

Mathematical Communication Ability (MCA) is a part of mathematics performance. In solving the questions that need MCA, the students also need Mathematical Communication Self-Efficacy (MCSE). Rahmi, Nadia, Hasibah & Hidayat (2017) examined that students self-efficacy influences students mathematical communication ability. But, there is no detail study about MCA of students based on level of MCSE. So that in this study, researcher will explain the description of MCA and MCSE of junior high school students and examine quantitatively whether or not there was a significant different between mathematical communication ability (MCA) of junior high school student according to their mathematical communication self-efficacy (MCSE) levels.

2 RESEARCH METHODS

This study used survey method type of quantitative research. The participants were 32 students of 7th grade in one of State Junior High Schools in Subang, West Java, Indonesia. To measure the students' mathematical communication ability, five questions are given for them. The topics of the questions are linear equations in one variable and social arithmetic. In this study, three indicators of mathematical communication are measured i.e. (1) transforming mathematical or daily life situation into mathematis model and solve it; (2) stating mathematics model (picture, diagram, or algebra expression) into daily life situation (word problem); and (3) posing the questions about the given situation with valid reason. The questions developed based on the indicators above.

In order to specify students' mathematical communication self-efficacy (MCSE), the MCSE scale was developed by researcher. The scale used was likert scale with the choice of answers were SS (strongly agree), S (agree), TS (disagree), and STS (Strongly disagree). The aspects measured for MCSE were (1) performance experience, (2) vicarious experience, (3) verbal persuasion, and (4) emotional arousal. Before used for the research, both of instruments were consulted to the supervisor and tested to check validity and reliability. For the result, the validity of both instruments are good. The reliability of Mathematical Communication Ability (MCA) test was 0,533, which mean it has a moderate level of reliability. Meanwhile, the reliability of MCSE scale was 0,858, it was categorized to high level.

For data analysis, there were two steps. First, grouping the students into three levels of self-efficacy i.e. low, middle and high self-efficacy. The criteria for grouping followed table of categorizing self-efficacy level (table 1) by Azwar (2015). Second, score of the students of each group was tested used One-Way Analysis of Variance (ANOVA). ANOVA was used in order to specify whether or not there was a significant different between mathematical communication ability (MCA) of junior high school student according to their mathematical communication self-efficacy (MCSE) levels.

Table 1. Categorizing criteria of self-efficacy level

Self-efficacy score (X)	Classification
$X < (\mu - 1{,}0\sigma)$	Low
$(\mu - 1{,}0\sigma) \leq X < (\mu + 1{,}0\sigma)$	Middle
$(\mu + 1{,}0\sigma) \leq X$	High

3 RESULT AND DISCUSSION

3.1 The Description of Mathematical Communication Ability (MCA) of Junior High School Students

The students' mathematical communication ability was obtained from the test. The result could be seen in Table 2. There were five questions to measure MCA of junior high school students. Based on Table 2 and student answer sheets, researcher found several findings. First, question number 5 was most difficult than the others. In the question, students were difficult to create a mathematics model since the problem was complicated and more information given in the question. If comparing with question number 1, question number 1 was easier than question number 5 because the problem was simple. This situation indicates that the difficulties faced by students in creating mathematics model and solving the question are in lack of understanding about complex word problems. The complicated word problems create the problem for students to solve the question. This is similar with a research by Bautista (2009) that complexities in the context of the problem caused enormous problems for students. Result in question number 3 was also found that students could not solve the question since failed in creating mathematics model.

Table 2. The result of MCA test

Item Number	Indicators of mathematical communication	Total Score	Maximum Ideal Score
1	Creating mathematics model from a problem related to linear equation in one variable then solve it	144	256
2	Translating mathematics model (linear equation in one variable) into daily life situation then posing a question related to the situation and solve it	84	224
3	Posing a question from a word problem related to linear equation in one variable then solve it	43	160
4	Writing a word problem about trading process involving concept of profit or loss	139	192
5	Creating mathematics model from a word problem about social arithmetic and solving the model	9	224

Second, students failed in translating mathematics model to daily life activity. Question number 2 asked students to transform model 4x = x +17500 into daily life situation. Most of them could interpret 4x correctly but they made error in interpreting x, they interpreted x as the other object and it was different from object in 4x. From the result, it can be inferred that the students do not have good understanding about meaning of variable. Third, students succeed in posing questions about the given situation but failed in solving them since to solve the posed question, they must transform situation into mathematics model and they was difficult to do it as explained before. Fourth, if the models were given, they could solve it correctly. It showed that the students have good understanding in calculation algorithms but poor understanding in solving word problem. This is consistent with Mayer and Hegarty (1996) who found that students were able to use successfully calculation algorithms meanwhile they were not able to solve word problems which need the same algorithms. Overall, the MCA of junior high school still need to improve especially in creating

mathematics model and understanding meaning of variables.

3.2 The Description of Mathematical Communication Self-Efficacy (MCSE) of Junior High School Students

After answer five questions of MCA test, the students were given a MCSE's scale. There were twenty five statements used to measure MCSE of junior high school students. Each statement measured the students perception about their ability in solving the question in MCA test. The result showed that the total score of 32 students was low in several statements i.e.

"I am difficult to understand the meaning of the given word problem";

"I cannot remember clearly about topic linear equation in one variable and social arithmetic that I have learned";

"I am afraid I cannot answer the question given by teacher";

"I am worried when learning mathematics";

"I hesitate if I see the answers of friends that are different from me"

"I am difficult to pose a good question about the given situation".

From the five statements above where the students got the low score in the statement, researcher found an interesting thing. Students perceived that they were difficult to pose a question about the given situation. In the previous section, researcher found that the students could pose a question when a situation was given. This case indicated that students have not good belief about their self to accomplish a task (pose a question). From the other four statements above, it could be inferred that students were still hesitant toward their ability in learning mathematics. This condition will be effect in students mathematics achievement since researches by Liu and Koirala (2009) and Soleymani and Rekabdar (2016), showed that mathematics self-efficacy and mathematics achievement were positively related.

3.3 The Mathematical Communication Ability (MCA) of Junior High School Students According to MCSE Level

To determine "is there a significant different between the MCA of junior high school student according to their MCSE levels?", One-Way Analysis of Variance was used. The result of descriptive data for MCSE levels and analysis are provided in Table 3 and Table 4 consecutively.

Table 3. Descriptive data for MCSE Levels

MCSE Levels	Mean of MCA's score	Number of Students
Low	11,00	15
Middle	15,36	11
High	16,00	6

Table 4. Results of One-Way Analysis of Variance

The Source of Variance	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	169,330	2	84,665	10,838	,000
Within Groups	226,545	29	7,812		
Total	395,875	31			

Result in Table 3 showed that the higher the level of MCSE, the higher mean of MCA's score. But, the difference between students with middle self-efficacy level and high self-efficacy level was very small.

According to the results of one-way ANOVA (sig. value < 0,05), it could be concluded that there was a significant different between the MCA of junior high school student according to their MCSE levels. Furthermore, to determine source of the difference, post hoc test i.e. Tukey HSD test was used. The result was provided in Table 5.

Table 5. Result of Tukey HSD Test

(I) Self-Efficacy Level	(J) Self-Efficacy Level	Mean Difference (I-J)	Std. Error	Sig.
Low	Middle	-4,364*	1,109	,001
	High	-5,000*	1,350	,002
Middle	Low	4,364*	1,109	,001
	High	-,636	1,419	,895
High	Low	5,000*	1,350	,002
	Middle	,636	1,419	,895

Based on Table 5, there was a significant difference between the MCA of the junior high school students with low MCSE level and the students with middle and high MCSE level. But, there was no difference between the MCA of the junior high school students with middle MCSE level and the students with high MCSE. By comparing average of MCA for each self-efficacy level, it showed that students with high self-efficacy also have good MCA and vice versa. It means that self-efficacy influences mathematical communication ability. It is supported by Rahmi, Nadia, Hasibah & Hidayat (2017) found that students self-efficacy influences students mathematical communication ability. In mathematics performance generally, a research by Liu and Koirala (2009) also showed that mathematics self-efficacy was a significantly positive predictor of mathematics achievement which means students who were confident of their ability in mathematics were more likely to have better mathematics achievement.

4 CONCLUSION

In solving mathematical communication ability test, students get some difficulties. They are (1) Students cannot create mathematics model correctly caused by failed in understanding complex word problem and (2) students does not know meaning of variables. For mathematical communication self-efficacy, students do not good belief toward their self to accomplish a task especially in solving questions involving mathematical communication ability such as pose a question from a given situation, but actually they can do it. Overall, the mathematical communication ability of the junior high school students is different based on their mathematical communication self-efficacy levels. For more detail, the students' mathematical communication ability with high and middle mathematical communication self-efficacy level is better than students' mathematical communication ability with low mathematical communication self-efficacy level. So that, in teaching mathematics, teachers must give more attention not only in improving cognitive skill but also in affective skill. The further research is needed especially how to improve students' ability in understanding complex word problems.

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