



The mathematical communication ability based on gender difference on students of XI grade by using problem based learning model assisted by probing prompting technique

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Abstract

This study aims to test the MCA (Mathematical Communication Ability) in Problem Based Learning (PBL) model assisted Probing Prompting Technique (PBL PP), to achieve learning mastery, to know the average ratio of MCA of students on learning model of PBL PP and PBL only, to differ the MCA of male students with female students in PBL PP, and to describe MCA of students based on gender difference. The method used in this research is mix method. While the population is science program students of XI grade at MAN 2 Semarang. The sample is chosen with random sampling. In addition, students of XI IPA 1 are as experiment class, while students of XI IPA 2 as control class. The qualitative research subjects in this study are six students, for each is taken three from every male and female students in experiment class. The results of this research are the MCA's students with PBL PP learning reaches the learning mastery, the average ratio of MCA in PBL PP is better than PBL model, the MCA of male and female students have no significant difference, and there are some differences of MCA in each indicators based on gender difference.

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1. Introduction

The role of the teacher is as the facilitator of the students in learning. NCTM (2000) states that every student must have more chances and supports to learn mathematics until they understand. One of the five abilities of mathematics which is necessary to have by students is the ability of mathematical communication. According to Ramdani (2012), mathematical communication is the ability to communicate which includes the usage activity of writing skill, observing, reviewing, interpreting, and evaluating idea, symbol, terminology, and mathematics information which is observed through the process of hearing, presenting, and discussing. Besides, Sefiany *et al.* (2016) reveal that the ability of mathematical communication is needed by students in delivering concepts or ideas of mathematics for both orally or written.

Based on the conclusion on the research of Lomibao *et al.* (2016), all of the students who are

being the subject of the research agree that mathematical communication is very useful for them. Then, it is supported by the opinion of Asikin & Junaedi (2013), that the process of communication is also help in building the meaning and make the idea becomes permanent and communication process and explain the idea. Besides, Anintya *et al.* (2017) state that the low ability of mathematical communication will impact to the decrease of mathematical ability and more. It emphasizes the importance of mathematical communication ability for students.

Owing to the situation of learning at XI grade of MAN 2 Semarang when doing observation, the participation of the students for actively contributing in learning is not seen yet. Whereas, the interaction in the class needs the activeness of the students. If the students cannot communicate properly and interpret the concept and other mathematical problems, it goes without saying that they cannot solve the problem properly (Alhaddad *et al.*, 2015). Though, the proper problem solving affects student's mathematical communication

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ability. In fact, the mathematics teacher in MAN 2 Semarang does not consider the ability mathematical communication of the students yet. Hence, the researcher tries to do class observation, interview with mathematics teacher, and collect the essay answers result of the students at MAN 2 Semarang. After that, the researcher analyzes the students' ability until gets. Apparently, students of MAN 2 Semarang still have low mathematical communication ability in general.

In order to strive for the ability of good mathematical communication, the appropriate learning model is strongly needed to be applied in every single parts of learning (Putri *et al.*, 2017). There are various strategies which show that there is no best way to teach, so the variation strategy becomes inevitability in achieving the learning goals. The teaching strategies to achieve the goals can be done by paying attention to the learning model applied. Prasetyo *et al.* (2017) state that mathematics concept and procedure often can be used to solve the problem in mathematics or others. Problem Based Learning is a learning model which is considered as a good model to be applied in 2013 curriculum nowadays. According to Murniati *et al.* (2017), PBL learning model is one of the learning model that has its own characteristic that is always start and center on the problem.

The study with PBL is appropriate to be applied to almost all of the material in mathematic class because mathematics is related to the ability in finishing the question and solving the problem, both of story question or not. As Sufi (2016)'s research which explains about the benefit of the PBL, that is can increase the mathematical communication ability of students. One of the material which becomes the focus of the researcher on analysing the ability of mathematical communication is linear program material for the material can solve many problems related to the real life, so, it is appropriate to the PBL model. With regard to that explanation, the model is expected can explore more clearly about the students' ability of mathematical communication.

In order to increase the students' activeness in facing problem given by the teacher, it requires another strategy which support the PBL model. One of the strategy that can help to explore the students' ability of mathematical communication is the technique of asking each other in learning process. According to Siregar & Fauzi (2016), in learning process, asking the question has important part because the well-structured questions will

increase the students' participation in learning process, guide them in thinking process, and focus the students' attention into the topic which is being discussed about. One of the strategy that can encourage students in order to be active in asking and answering session both with the teacher or friends is the Prompting Probing technique.

According to Larsson (2007), giving the questions to the student is able to encourage them to do small presentation that can increase the students' ability. The teacher has to ask the students to express the mathematics ideas especially orally because in this activity it is easy for teacher to find out how far students' mathematical communication ability is. Hence, in this study, the researcher performs the learning process using Probing Prompting technique.

Furthermore, in this study, there are several factors in students' learning process, especially the cognitive aspect which is related to the ability of brain. According to Evania, the development of brain is related to the development prefrontal cortex which is most responsible to the ability of human cognitive, and some researches show that there is physical difference between the brain of male and female in structure and physiologic (Triyadi, 2013). Based on it, the difference of brain's ability of male and female is also can affect to the learning process in class. The gender term often exists in academic area and famous discussions in dynamic social experience which includes educational experience in intern and extern of school (Glasser & Smith, 2008).

Gender comes from Latin language "*genus*" which means the type or kind, that in gender descriptive is a character and attitude that are placed on male and female that is formed socially and culturally (Amir, 2013). It can not be denied that from those differences on men and women, the impact is also spread into education world. Krutetski explains that the difference between male and female in mathematics learning is the male become more superior in logical, while the female become more superior in accuracy, precision and focusing thinking. In addition, the male have mathematics mechanical ability which is better than female (Amir, 2013). The research result conducted in Kenya shows that the male are more success in learning mathematics than female (Githua & Mwangi, 2003). However, there is other research argues that the mathematical ability of male majorly is under the female's (Triyadi, 2013). From the various researches' results, the mathematical communication is seen from gender

differentiation of the students in order to know the difference in every aspects.

Furthermore, the factual condition of learning at MAN 2 Semarang through the students' mathematical communication ability is still in low level. The various researches about Problem Based Learning model and Probing Prompting technique are already conducted owing to the fact that it is good enough to explore students' ability of mathematical communication. It encourages the researcher to analyze the students' ability of mathematical communication at XI grade of MAN 2 Semarang through Problem Based Learning model assisted Probing Prompting. Besides, the researcher also wants to describe the mathematical communication ability reviewed from gender.

2. Methods

This study is mixed method study that is combining quantitative and qualitative method. The design of combination research used is sequential explanatory. It is the combination research that combine quantitative and qualitative research method sequentially in which the initial research is done by using quantitative method and on then processed by qualitative method. Quantitative method is done in order to get the measured qualitative data and has character of descriptive, comparative, and associative, while qualitative method is done in order to prove, deepen, spread, weaken, dan abort the qualitative data which have been got from the beginning level (Sugiyono, 2011).

The design of this study is quasi experimental design in form of post-test control. In this research, the population is XI grade of science students at MAN 2 Semarang on odd semester academic year 2017/ 2018 which is divided of 5 classes. While the sample of this research was done by random sampling. The students who become the sample of research are students from XI IPA 1 and XI IPA 2. The XI IPA 1 class became experimental group, while XI IPA 2 class became control group.

Furhter, quantitative research used to know the superiority of mathematical communication ability through Problem Based Learning model assisted Probing Prompting technique and know the difference of the mathematical communication ability of male and female. Previously, the researcher has prepared the instrument of the reasearch that is composed of sets of study, answer sheets of mathematical community ability and

assessment sheets of students' activity. The material of study used in this research was linear program. This quantitative data were obtained from the test of Mathematical Communication Ability (MCA). One class has already achieved classical completeness, if the minimum is 74,5% from amount the students in the class who have achieved the minimum completeness criterion that is 70. The analysis of quantitative data is conducted in order to know the superiority of mathematical communication ability through the Problem Based Learning model assisted Probing Prompting technique using two experiments, namely classical completeness experiment and two averages difference experiment (right side). While the quantitative data analysis is to find out the difference of students' mathematical communication ability for male and female using two averages difference experiment (two sides).

The qualitative research is used to get the answer of research problem, that is how to describe students' ability of mathematical communication in linear program which is evaluated from gender difference. The subject of this qualitative research is 6 students from XI IPA 1 class consist of 3 male and 3 female. In order to determine the research subject, the researcher took the male and female with the result of the test, the highest MCA in every gender groups. In this research, the previous researcher is preparing the research instrument such as, question sheet of mathematical communication ability and interview guidance. The technique of collecting data used is documentation, MCA test, and interview.

The documentation is used to get the data of students' name and list of students' score which is needed as the research data. Besides, the documentation is also can be form as video recording of some parts of mathematics learning process using PBL model assisted Probing Prompting technique and the recording of interview result with students who are being the subject of the research. The test method used to get the score of students' mathematical communication ability in research class. The interview used to get the data directly concerning about the students' mathematical communication ability who are being the research subject.

3. Result and Discussion

According to the students' ability test of mathematical communication that get PBL

learning assisted Probing Prompting technique, the determination of this research subject is classified into group male and female categories with the highest score in every group as presented in the Table 1.

Table 1. Grouping of Research Subject

Code	MCA's value	New Code
Male Category		
E-22	91,7	L-01
E-10	81,7	L-02
E-23	80	L-03
Female Category		
E-03	93,3	P-01
E-21	90	P-02
E-28	86,7	P-03

Moreover, for making it easier, the subject is given a new code; the male category is called L-01, L-02, and L-03, while, the female category is called P-01, P-02, and P-03.

3.1. Quantitative Data Analysis

After conducting the study for four meetings both in experimental and control class as well as conducting the MCA test, the researcher did data quantitative analysis. Based on the observation result towards study into the model of Problem Based Learning assisted Probing Prompting, the results of experimental result of MCA test are explained in the following explanation .

3.1.1. Normality Test

The normality test has been done to find out that the data comes from population in normal distribution. The normality test uses *SPSS 16.0* software on *Kolmogorov-Smirnov* test. The result of data normality test on daily test score shows that in XI IPA 1, the value of *Sig.* is 0,156 which means that the *Sig.* is more than 0,05. While in XI IPA 2 the value of *Sig.* is 0,191 which means that the *Sig.* is more than 0,05. It means that H_0 is accepted. In brief, it can be noted that the data of the test comes from the population in normal distribution

3.1.2. Homogeneity Test

The homogeneity test has been done before the study in order to know that the data of daily test value has homogen varians. The data homogeneity test uses *SPSS 16.0* software on *Levene* test. The result of homogeneity test analysis shows that *Sig.* = 0,900 > 0,05. That H_0 is accepted. It means that the

varians of data daily test value in experimental and control class are homogen.

3.1.3. Classical Completeness Test

The classical completeness test is done to test the ability of mathematical communication in class that used learning model of PBL assisted Probing Prompting technique that can achieve classical completeness. Based on the result of data analysis, daily test value of students in experimental class proves that the data comes from population in normal distribution. Thus, to test the ability of classical completeness in students' mathematical communication is by using parametric statistic. The computation is done by using *SPSS 16.0* and get the result that *Sig. (2-tailed)* = 0,494 > 0,05. It goes without saying that H_0 is rejected. It means that the students proportion who get test score of mathematical communication ability is more than 70 in class that using learning model of Problem Based Learning (PBL) assisted Probing Prompting technique more than 74,5%.

3.1.4. Two Averages Differentiation Test (Right Side)

The two averages differentiation test (right side) is done to test the difference of average score test of students' mathematical communication ability in class that using learning PBL model assisted Probing Prompting technique and PBL model. Based on students' daily test data value analysis in experimental and control class shows that the data comes from the population in normal distribution and homogen. Thus, to test the students' difference of MCA average value test using parametric statistic. The computing is done by using *SPSS 16.0* and results *Sig.* = 0,063 > 0,05. So, H_0 is rejected. It means that students' mathematical communication ability in class by using PBL+ assisted Posing Prompting technique is better than by using PBL model.

3.1.5. Two Averages Differentiation Test (Two Side)

The two averages differentiation test (two side) was done to test the difference and significance of test score of mathematical communication ability between male and female students in class that use PBL model assisted Probing Prompting technique. Based on the normality and homogeneity test, it shows that the data comes from population in normal distribution and homogen. So, to test the difference of students' MCA average test score uses parametric statistic. The computation is done

by using SPSS 16.0 and results the score that $Sig. (2-tailed) = 0,875 > 0,05$. Obviously, H_0 is accepted. It means that there is difference ability of mathematical communication of male and female students in class that use PBL model assisted Probing Prompting technique.

By doing analysis in the form of MCA average score test of comparison in every indicator between male and female in class XI IPA 1, it can be seen on the chart in Figure 1. The following chart is expected being able to encourage the equalitative research in form of students' MCA quality analysis reviewed from gender difference.

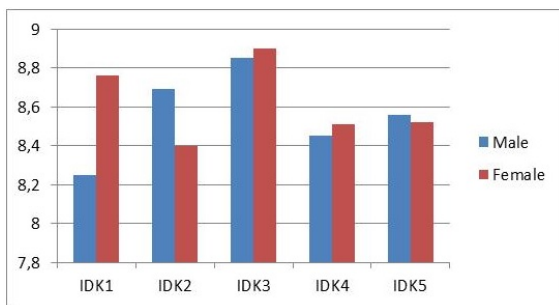


Figure 1. Chart of Mathematical Communication Ability

3.2. Qualitative Data Analysis

In this research, the mathematical communication ability is classified into two parts, as follows: analysis of mathematical communication ability on the subject of male and female. The result of mathematical communication test that consists of three questions is scored with scoring guidance that is done in every indicator, with mathematical communication achievement consists of four scores from 0 until 4. Then, based on the data MCA result test per indicator and from the interview with the six subjects of research, as well as the triangulation technique can be done. The triangulation technique is the researcher's effort in using collecting data technique which is different in order to gain the data from the same source.

One of the research subject that will be explained is from the answer result of mathematical communication ability test and subject's result interview P-01. According to the answer from subject P-01 in question number 3, he has able to mention the steps in solving the problem, that is by writing what has known and asked. It can be seen from the his answer in the following Figure 2.

3 D.	Jenis Kopi	Kopi Brazil	Kopi Lampung	Harga
anak		20 gram	20 gram	Rp.12.000,00
Sedap		30 gram	10 gram	Rp 9.000,00
D.	Jumlah	18 kg	10 kg	-
		18000 gram	10.000 gram	

Figure 2. The Example of Answered Text of Number 3 Subject P-01

While from the interview result with subject P-01, he is able to explain the problem solving steps in linear program in question number 3. It means that subject P-01 has completed the indicator of showing the steps in problem solving (IDK1). The indicator of strategic idea in problem solving (IDK2), the test answer of subject P-01 can be seen on the following figure.

3 D.	Jenis Kopi	Kopi Brazil	Kopi Lampung	Harga
anak		20 gram	20 gram	Rp.12.000,00
Sedap		30 gram	10 gram	Rp 9.000,00
D.	Jumlah	18 kg	10 kg	-
		18000 gram	10.000 gram	

Figure 3. The Example of Answered Text of Number 3 Subject P-01

Based on the figure above, it shows that subject P-01 is able to write the strategic idea in problem solving well and structurally. In the problem solving, he uses elimination and substitution method to find out slice point of the lines. While from the interview result, he is able to explain the strategy used to complete the question number 3. Shortly, subject P-01 has completed the indicator to express the strategic idea in problem solving (IDK2).

Then, in the indicator of providing the idea in form of picture, table, or chart (IDK3), the answer of subject P-01 can be seen in the following figure.

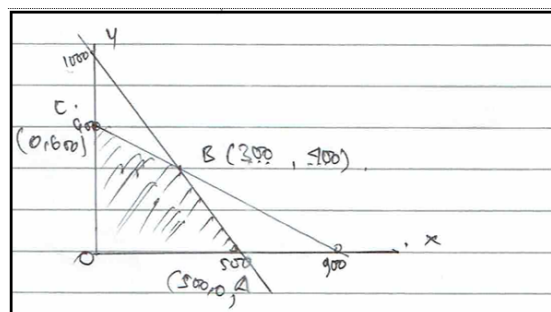


Figure 4. The Example of Answered Text of Number 3 of Subject P-01

The figure 2 shows that subject P-01 is able to make chart in problem solving completely and clearly and make the result area in form of hatching. In addition, from the interview result, subject P-01 is able to explain the process of making the chart. It means that subject P-01 has been completed the indicator and provided the idea

in form of picture, table, or chart (IDK3) completely and correctly.

Then, for indicator IDK4 or indicator of writing the conclusion in problem solving which is appropriate to the mathematical concept, the student has written correctly yet not completely because the answer only refers to point a and he has not answered the poin b yet. On the contrary, from the interview result, subject P-01 felt that he has written all of the answer well. Hence, subject P-01 is considered has been correct yet not complete in achieving the indicator of writing the conclusion in problem solving which is appropriate to the mathematical concept.

On the indicator, there is terminology and mathematics symbol in providing idea (IDK5), the test answer of subject P-01 can be seen in the Figure 2.

$2x + 3y = 1800$		$2x + y = 1000$. Titik potong Z_{max} :	
x	0	300	x	0	500
y	600	0	y	1000	0
$C(0, 600)$		$D(300, 0)$		$A(500, 0)$	
$B(0, 1000)$		$E(300, 400)$		$F(900, 400) = 7200000$ ✓	
$A(500, 0) = 6000.000$		$C(0, 600) = 5400.000$			

Figure 5. The Example of Answered Text of Number 3 Subject P-01

Based on the figure, subject P-01 is able to write terminologies and symbols of mathematics correctly, that is write the example clearly (x and y), symbol inequality clearly (\geq), but is not explain $SPtLDV$ with symbol ($\{$) on the obstacles have been structured. Besides, on the step in counting points x and y that complete the obstruction, subject P-01 has changed inequality form into equation. The writing in the function of objective is also has been appropriate that is by using function symbol Z_{max} . It also happens when making the chart, subject P-01 can write coordinat symbol and coordinat point correctly and clearly. Then, from the result of interview with subject P-01, the student is able to explain the methodology used in providing idea on question number 3. Thus, it means that subject P-01 has completed the indicator to write the methodology and mathematics symbol in providing idea clearly and completely.

The qualitative explanation based on the test result of mathematical communication ability, interview result, and triangulation toward six research subjects. From observation above the indicator shows the steps in problem solving (IDK1), the mathematical communication ability of female students is better than male students. On the indicator, there is the strategic idea in problem solving (IDK2), the mathematical communication

ability of male is better than female students. Then, on the indicator of providing the idea in form of picture, table, or chart (IDK3), the mathematical communication ability of male and female are same as well as in indicator writing the conclusion in problem solving which are appropriate to the mathematical concept (IDK4). While on writing therminology and mathematics symbol in providing idea (IDK5), the mathematical communication ability of female students are better than male students.

4. Conclusion

Based on the description of analysis above, the conclusions that can be drawn are the students' mathematical communication ability in learning PBL model assisted Probing Prompting technique achieved classical completeness, the students' mathematical communication ability by using PBL assisted Probing Prompting learning was better than by using PBL learning, and there was no significant differences between male and female students on PBL learning. Qualitatively, there was MCA difference in every indicator between male and female students; female is better on indicator of solving the problem, writing methodology and mathematics symbol, providing idea, while the male is better on the indicator of strategic idea in problem solving. In addition, male was same with female on the indicator of providing idea in form of picture, table, or chart and writing conclusion in problem solving which is appropriate to mathematical concept.

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