Probing prompting in symbolization

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Abstract. This study was conducted as descriptive research which purposed to find out mathematical thinking aspects of symbolization of the first secondary school through probing prompting learning strategy. The subject of this study were 6 students of class VIII.1 in junior high school. The learning proses was taken place by steps and probing prompting learning strategy. The data was collected by using test and interview which was analyzed qualitatively. The result of this study indicates that student 1 was able to bring up both indicators of symbolization, but the ability algebraic operation was still erroneous. Student 2 can bring up the indicator of symbol manipulation.

1. Introduction
Mathematical thinking is the mathematical ability to use mathematical thinking to solve problems is an important goal of the school. In this case, mathematical thinking will support science, technology, economic life and development in an economy [1,2,3]. Mathematical thinking is very important to be mastered by students, as stated in Permendiknas number 21 of 2016 on basic and secondary education content standards there is one thing that is expected that students can think critically, mathematically, independently, collaboratively and communicatively, reasoning skills both deductively and inductively [4]. Mathematical thinking aspects of symbolization is mathematical thinking aspects of symbolization that is thinking about how to symbolize the existing problems. According to [5] the symbolization aspect is divided into 2 indicators, namely symbolic manipulation, and algebraization. Manipulation of symbols and algebra is a related unit, namely the ability to change the statement of the form of the story into mathematical symbols [6]. Manipulation of symbols is the result of the process of abstraction that is symbolizing every problem that exists, can be symbolized through the symbol of the operation or can also be symbolized by using letters such as "a", "b", "c", and so forth while algebra related in this study namely the ability of algebraic operations. Unfortunately, the mathematical thinking ability of students in Indonesia is still relatively low.

Data of PISA 2015 shows that Indonesia gets the lowest 9 from the bottom for mathematics with a score of 386 with the ability at levels 4-6 only 0.8% and at level 1 and 2 42.3% [6]. This is also reinforced by the data obtained from the score of the Indonesian national exam in 2019 that the lowest average value is in mathematics with the average grade of state junior high school that is 46.56 [7]. This is also in line with [8] which stated that the ability to solve mathematical problems of junior high school students on linear equation system in two variables is relatively low to apply to everyday life. The ability to manipulate symbols and algebra students is still very low based on research conducted by [8]. Many students who have not been able to convert statements that are known into mathematical symbols, for example, the ability of students to change statements using the context of debt, the direction of the wind, direction of travel. These findings are in line with research conducted by [9] which states that students have difficulties in understanding the meaning of the problem and in solving
the problem correctly. This is also related to research conducted by [10] the ability to manipulate symbols and algebra in age problems in the linear equation system in two variables students who have not been able to make equations related to the statements contained in the problems [11].

In addition, based on research conducted by [12] which states that the ability of students in solving problems of linear equation system in two variables is still low in the algebraic operations section and the ability to manipulate symbols and algebra students is still very low. This is based on research conducted by [13] students to change statements using the context of debt, the direction of the wind, the direction of one's journey many students who have not been able to change statements that are known to be mathematical symbols. That is due to the strategies and learning models applied by school teachers only by the lecture method, students are not too required to be active in learning, so students are not accustomed to practicing mathematical thinking in solving problems. Research conducted by [14] states that the teacher usually teaches students by demonstrating the procedure of solving linear equation system in two variables and ask them to follow so that the students are not facilitated to construct their new knowledge. Based on research conducted by [15] one of the good learning strategies for linear equation system in two variables material is probing prompting learning strategy than using conventional learning.

Besides that, the thing that causes the students' mathematical thinking ability is low, that is they do not understand mathematical concepts, especially in the material of the linear equation system in two variables. As already stated in the research [16], students’ error in solving the problem of linear equation system in two variables are that they cannot retrieve information well, cannot transform the problem, do not understand the material completely, do not have enough knowledge of prerequisite material, have not enough experience in solving problems, and are less careful in accomplishment. Therefore, a study about symbolization aspect of mathematical thinking with the probing prompting method for student grade 8 was conducted.

2. Method
The method of this research is descriptive qualitative which aims to find out the mathematical thinking aspects of the symbolization of Grade VIII students of SMP Negeri 33 Palembang in learning mathematics through probing prompting learning strategies. The variable in this study is mathematical thinking aspects of the symbolization of class VIII SMP in mathematics learning. Mathematical thinking aspects of symbolization in this research is mathematical thinking in solving problems that must be possessed by someone to solve a problem. The subject of this research is class VIII.1 of SMPN 33 Palembang, which consists of 6 students in learning mathematics with the linear equation system in two variables through probing prompting learning strategies. Probing prompting strategy is a technique in learning that uses probing and guiding questions so that students are directed in more correct answers.

Data collection instruments used in this study were tests and interviews. The test is in the form of essay questions which amounts to 2 questions and is answered according to the procedure of how to solve the material of the linear equation system in two variables. Interviews were conducted to see the mathematical thinking process aspects of the symbolization of students and see abilities that have not been seen when answering test questions. The subject of the interview was chosen based on the results of the test answers which were considered quite interesting with the ability to appear different indicators. In this study, the research subjects were 2 students with symbol manipulation and algebra indicators, but one of them was wrong, 1 student appeared symbol manipulation and no algebraic operations appeared but integer operations appeared with different settlement methods from the linear equation system in two variables settlement method. So that a total of 3 students are the research subjects. The data obtained from the results of the interview were analyzed by changing the results of the oral interview into written form and analyzing the answers of the interviews.

3. Result and Discussion
This research was carried out in class VIII.1, SMP N 33 Palembang from 4 September 2019 to 18 September 2019. This research was conducted in 3 meetings, 2 learning activities meetings and one final meeting for the mathematical thinking aspect symbolization test. Learning is carried out
according to the steps of the probing prompting learning strategy. Data on mathematical thinking aspects of symbolization students were obtained from the results of tests and interviews using the type of mathematical thinking aspects of symbolization questions. The test was conducted at the third meeting which consisted of 3 essay questions that had been validated by 2 FKIP Unsri Mathematics lecturers namely Novita Sari S.Pd., M.Pd and Novika Sukmaningthiyas., M.Pd. and 1 mathematics teacher at SMP N 33 Palembang, namely Hj. Siti Jamilah S.Pd., MM. When the test took place as many as 6 students attended and took the test at the end of the meeting which was done individually. Assessment is based on indicators that appear on the answers to the test questions. Each question consists of 2 indicators, symbol manipulation indicators, and algebra indicators.

In the next step, from the 6 student answers, the most interesting student answers were taken and based on the indicators that appear. Students are the first or called S1, the idea of mathematical thinking aspects of symbolization with indicators of symbol manipulation and algebra has emerged but at the time of work, there was a mistake in algebraic operations. The second student or S2, the idea of mathematical thinking aspects of symbolization with indicators of manipulation of symbols has emerged, but during algebraic operations do not appear because S2 answers in a different way of solving linear equation system in two variables, but the ability of integer operations appears well and thinks to solve problems very good. The third student of mathematical thinking ideas aspects of symbolization with indicators of symbol manipulation and algebra has emerged but there are errors in algebraic indicators with algebraic operations.

3.1. Student’s Answers that Appear Two Indicators but One is Wrong
The results of students’ answers with indicators of symbol manipulation and algebra appear both but one indicator is wrong. Student answers can be seen as follow.

![Figure 1. Student answers that appear two indicators but one is wrong.](image-url)

Based on the test results of the student's answers as a whole indicator of mathematical thinking aspects of symbolization with indicators of symbol manipulation and algebra has emerged. Through probing questions or probing students can determine the information that is known, explore the knowledge that students know is the formula for speed. Through guiding statements or prompting students can assume statements that are known with variables, can make equations based on mathematical symbols and solve up to the stage of algebraic operations. But in the algebraic stage with
algebraic operations there is a mistake, S1 adds the number 10 on the left side but it isn't added in the right segment, so the final results obtained by S1 are not yet right. After working on the test questions, the researchers conducted interviews to look at the students' mathematical thinking processes and to accurate data that had been obtained from the test results. At the time of the interview, the researcher asked whether the answer was correct, S1 began to check the answer and realized his mistake in completing the algebra operation so that when the researcher asked for the correct answer, S1 was able to answer correctly and correctly. In this case, S1 is less thorough in solving a problem that causes S1 to bring up the wrong indicator, following the internal factor in the diagnosis of learning difficulties namely concentration in learning [17].

3.2. Student Answers that Appear One Indicator
The results of student answers that appear one indicator but the final result is correct. The following figure is the results of student answers.

Figure 2. Answer of student 2 that appear one indicator.

Based on the answers S2 above, students have been able to solve the problems given, but not following the procedure in solving problems of linear equation system in two variables, through questions that are probing or probing students can emerge symbols manipulation indicators, S2 can make examples, able to separate buffalo picture and bird picture on two cards that are square and triangular. In the guiding question, S2 is not able to create a system of two-variable linear equations and has not been able to write what is done after getting linear equation system in two variables, and in the guiding question, students have not yet raised algebraic indicators with algebraic operations, but students answer by describing in detail the answer, by bringing up the integer operations correctly and correctly so that it finds the correct answer results. after the researcher knows the S2 mathematical thinking ability through the test results, the researcher conducts an interview with the S2 with the interview results that the S2 can complete by completing linear equation system in two variables, but the S2 chooses the method because it is easier to solve, with uncomplicated calculations, even though the mathematical thinking ability aspects of symbolization S2 have emerged based on both indicators of mathematical thinking aspects of symbolization.
3.3. Discussion

From the results of tests and student interviews conducted at the third meeting, it can be concluded that mathematical thinking aspects of student symbolization after carrying out learning using the probing prompting strategy is that students can bring up indicators of symbol manipulation and algebra. With the details of 4 students appear indicators of symbol manipulation and algebra but in algebraic operations there are errors and 2 students appear indicators of manipulation of symbols.

Students who appear both indicators of mathematical thinking aspects of symbolization when the learning process takes place with these strategies, students follow the steps that have been instructed through the probing prompting strategy. Because based on research [18] by using the probing prompting strategy has increased the ability to manipulate symbols and algebra to solve the problem of linear equation system in two variables. This is also influenced by activeness in practicing to answer questions [10]. Based on these statements the emergence of the two indicators of symbolization due to accustomed in practicing answering questions and being active in the learning process of probing promoting strategies. Students who appear indicators of manipulation of symbols and algebra but there are errors in the algebraic operation stage due to lack of practice in solving problems. This is in line with [19] the ability of algebraic indicators in algebraic operations because students lack training in solving problems of algebraic operations. In addition, students who only appear 1 indicator are students who are not actively involved during the learning process by not following the given instructions so that the algebraic indicators at the stage of algebraic operation do not appear.

4. Conclusion

Based on the results of research in class VIII.1 State Junior High School 33 Palembang, the results obtained that symbolization aspects of mathematical thinking through probing prompting learning strategies in S1 appear wrong indicators of symbol manipulation and algebra, S2 appears the ability to manipulate symbols.

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6. References

[1] Stacey K 2011 What Is Mathematical Thinking And Why Is It Important? Online: http://www.criced.tsukuba.ac.jp/math/apec/apec2007/paper_pdf/Kaye%20Stacey.pdf
[2] Scusa T 2008 Five processes of mathematical thinking Summative Projects for MA Degree (Lincoln: University Of Nebraska)
[3] Katagiri S 2004 Mathematical Thinking And How To Teach It (Tokyo: Meijitosyo Publishers)
[4] Kemendikbud RI 2016 Permendikbud No. 21 Tahun 2016 Tentang Standar Isi Dikdasmen (Jakarta: Kemendikbud)
[5] Nepal B 2016 IOSR-JRME 6 46
[6] OECD 2016 Programme For International Student Assessment (PISA) Result From PISA 2015 (Paris: OECD Publishing)
[7] Kemendikbud 2019 Laporan Pemeriksaan Nasional (Jakarta: Pusat Penilaian Pendidikan Kementerian Pendidikan dan Kebudayaan)
[8] Suraji, Maimuna and Saragih S 2018 JME 4 9
[9] Pulungan R R and Suhendra 2019 J. Phys.: Conf. Ser. 1157 042113
[10] Smith, J and Thompson PW 2007 Quantitative reasoning and the development of algebraic reasoning. In J.J. Kaput, D. W. Carraher and M L Blanton (Eds.) Algebra In The Early Grades (New York: Erlbaum) pp 95-132
[11] Filloy E, Rojano T and Solares A 2004 Proceeding of the 28th Conference of the International Group for the Psychology of Mathematics Education vol 2 (Bergen: Bergen University College) p 391
[12] Idris F H, Hamid I and Ardana 2015 Jurnal Matematika dan Pendidikan Matematika 3 92
[13] Peled I and Carreher D W 2008 Signed numbers and algebraic thinking ed J Kaput et al
   Algebra in The Early Grades (New York: Routledge) chapter 12 p 303
[14] Pangaribuan F 2018 J. Phys.: Conf. Ser. 1088 012071
[15] Azizah G N and Sundayana R 2016 Jurnal Mosharafa 5 305
[16] Rohmah M and Sutiarso S 2017 EURASIA J. Math. Sci. Tech. Ed. 14 671
[17] Lamba S, Rawat A, Jacob J, Arya M, Rawat J, Chauhan V and Panchal S 2014 IOSR-JNHS 3 1
[18] Susanti E 2017 Jurnal Pendidikan Matematika Raflesia 2 1
[19] Tukidjo D H 2014 Jurnal Elektronik Pendidikan Matematika Tadulako 2 34