Students’ difficulties in solving algebra task in middle school

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Abstract. Algebra is an essential topic in learning mathematics. It is a tool for solving the problem in the related phenomenon in our world. It gives the students the strategies on how to think systematically and coherently. Transition arithmetic to algebraic is still a considerable aspect of mathematics education. The habitation of solving problems using numbers becomes a way for students to get the solution to the mathematics problem. While the letters become a mathematical problem, students are trouble to solve it. For that reason, we try to examine the students’ difficulties in generalization and the equality aspect. The qualitative method was chosen from this study, then the analysis of the data by using the description style. The subject of this study is the students in grade eight and have studied algebra domain. This study found that the students have difficulty while generalizing the patterns and equality concepts.

1. Introduction
The mathematics education researchers and educators all over the world have investigated the problems students have with algebra. Algebra is virtually one of the fundamental topics in student’s mathematics learning and an essential topic in middle school. The curriculum contained in algebra is a gateway for students to continue their studies and create students as professional workers in today’s social life [1]; however, the research finding many students have been experiencing enormous difficulties in learning algebra [2,3,4]. The caused of student's challenges with algebra is by the time and the ways of introducing it in schools. Then the other caused that many students’ middle schools and high schools are not motivated to learn algebra[5].

In Indonesia, the algebra curriculum, the 2013 curriculum, conduct the initial topic of algebra in 7th-grade semester 1. The issue in the first semester begins with the introduction of integers. Followed by the set, then the algebraic form, linear equations, and the inequality in one variable. While for 8th grade, students learn topics in the forms of number patterns, Cartesian coordinates, relations and functions, straight-line equations, and one variable linear system equations. From that arrangement of the curricula, it can be seen that the algebra topic is given to 7th-grade students after students learn about arithmetic. These indicate that students directly encounter the algebraic concepts. For that reason, there are needed the bridge for the students to learn algebra smoothly so that they are not astounded during facade algebra.

Topic algebra is still a compelling case in mathematics education, especially in Indonesia education. The results of the international test, The Trend in International Mathematics and Science Study (TIMSS), caused its topic to become a consideration topic. Indonesia participated in this event from 1999 until 2015. From 1999 until 2011, Indonesia participated in 8th grade, but in 2015, Indonesia joined in 4th grade. The result in 2015 for fourth grade and 2011 for eighth grade, Indonesia
students, got a lower point than other Asian countries. The representing problem from theses items tasks shows that the students have difficulties solving the number task and the algebra task. This aspect is interrelated but different in interpreting the meaning of the symbol and concept. Mostly in primary grade, students learn about a number, and in middle school, students learn algebra. Number and algebra are the crucial topics in first grade in middle school, and they are requisite a transition thinking of the student from the arithmetic to algebraic.

The case of the transition from arithmetic to algebra is to be a critical issue for Indonesia students, and we can show it in TIMSS 2015 results. We can look at the task of the topic of a growing number. For its task, the Indonesian students got the lowers score. Only 51% of Indonesian students could answer this item correctly from 8.319 students who participated in this event, that it was significantly below the international average of 69%[6]. It means that the students participating in TIMSS 2015 have difficulties solving this item. A growing number is a topic in elementary school in grade fifth. Then the continuing these topics, it will be lead to generalized numbers. Here is the interconnection between these topics. Thus, arithmetic and algebra differ primarily in that arithmetic focus in computational fluency and algebra focus in relation — the integration of algebra to lead a wealth contribution in identifying characteristics of algebra.

The issue of how to attain the students successful in learning algebra is how the students in the middle could are thinking algebraically. In middle school, the emphasize on algebraic thinking is a way of the student to success in learning formal algebra. Algebraic thinking has a fundamental aspect that included in its activity: that is, generalization, equations, function, and equality[7]. The thinking required a solving problem, extended the method to develop students' ability then try to make abstraction and logically mathematical model to attain the solution.

In this study, there is a lot of tasks algebra that is given to the student. It contains the core concepts of algebra. The purpose of the task is to examine the student's difficulties after learning algebra topics either in grade seventh or grade eighth and how their way to solve the problem. In this article, we give attention to how the students can generalizing the pattern and find quantities relationship to gain equality concepts.

The concept of generalization in algebra is how the students find generalizations and symbolize by looking at the relationships between these numbers. The questions are given to students required an analysis of the structure of the pattern, then make it a connection between the quantities from the patterns, organize information systematically, and check generalizations about the interrelationships. These generalized relationships are formed later, in turn, allow for exploration and prediction of new situations, broadening the horizon even further. The tool that we can do is to place the table representation role. In algebra, tables have a tool in solving problems, for example, to investigate patterns[8]. To concepts in a relationship is a domain in the algebra aspect.

Then, the concepts of equality and its symbols are bases of algebraic understanding and always are used in the most level in school mathematics. Equality is also about the relationship between quantities. The core meaning of equality is connecting, showing that two mathematical expressions that have the same value[9,10]. The hint from equality is the relationship between arithmetic and algebra by noting the equal sign. Most of the students will be misled about these expressions. For example, when the problem started, “5+24=?” the students directly can answer this problem correctly. On the other side, if the students are given the question, “8+4=□+5”, their understanding of the answer mostly writes 12 and 17 [11]. The equal sign is the most prevalent symbol in understanding the mathematical idea, and it is an operational symbol rather than a relational symbol [12]. In algebra, the meaning of notion the equal sign is equivalence two mathematical expressions. The student needed attention, and understanding about the equal sign is not as a symbol in operation but in the relationship.

2. Methods
This study took the form of qualitative research; in that particular aspect was a case study for students in 8th grade. In this study, we followed five-steps in qualitative research [13]. It was the first about the
identification of the phenomenon to be studied for the student while solving an algebraic problem. The second was the identification of the students who would take part in this study. The third was a generation of hypotheses, what the problem was that student's difficulties while solving an algebraic problem. Then the fourth was data collection from students answered sheet and interviewed students to acquire more in-depth information about their thinking and difficulties and how they were developing the idea. The last point was the interpretation and conclusion. In this paper, we chose students in private secondary school at Bandung in 8th grade. The school included a teacher who has taught for five years. The students already studied algebraic material either in seventh or 8th grade in the previous semester. This purpose of the student in 8th grade we chose that because we want to know and examine the understanding of students about algebra either they learned in grade seven or eight.

Furthermore, the type of this research was as follows in the descriptive style. A descriptive study is a research that intended to describe the existing phenomena, either natural or human-made at present or in the past. The aspects might be in the forms of activities, characteristics, changes, relations, similarities, and differences between one issue and the other. This study focused on the student's achievement while solving the algebra task about the generalized number, variable, and equality — the instrument that the researcher developed with an open question by using an indicator that related in the algebra domain Indonesia curriculum. Twenty students took part in this study with different academic abilities.

3. Result and Discussion
This study uses an evaluation test in the form of a formative test to get specific about students' understanding of the algebra domain. The researcher tries to make a mathematical task based on the algebraic domain in grades 7 and 8. In the first stage, the researcher makes the tasks, and then it will be given and discussed to the experts. Based on the results of the expert, the task is revised and adjusted. The suggestion given by experts is that the task should be adjusted with indicators and the cognitive abilities of students, and it does not give the double meaning. After the suggestion of the experts has been revised, the task could be given to the students.

Two mathematical problems are highlighted in this paper. The first problem is how the students generalize from a pattern, and the second problem is how the students understand about equality. These questions represent an overview of students' understanding after learning algebra. Because the students have already been studied algebra, we expected they have an algebraic method while solving the problem. The relationship between numbers appears for the students while solving ad find the solution.

The first problem that stated in this problem is how the students find the algebraic rule as a generalized form in pattern generalization. The tool is a table containing known numbers like in the figure tasks, as guidance for solving this problem; after that, the students continuing the number until the unknown number to find the generalized form. Mostly the students solve by counting one by one the number then try to find the 30th figure that represents. Here is the example task of the student. The student finds the total number of the square by counting one by one using the differences every the total number figures. It is looking at the messy solution, but it is the correct answer. For his answer sheet, he is mostly using arithmetic calculating; it does not lead to algebraic thinking. The student does not yet find the algebraic rule and find a generalizing. The students feel confident by doing the calculating than using a generalized form.

The difficulties of the students from the task of the pattern are to form the generalized number likely $n [14]$. To find the generalized form, students should think harder than usually using arithmetic. So the procedure using arithmetic mostly students using in solving the problem. Only four students can solve this problem by using algebraic rule; sixteen students needed an arithmetic tool to solve this problem.

The second problem that stated in this problem is how the students understand equality. The students are given the basic calculation in the aspect of equality. While the students think to add the number, it will give the students attention just for calculation, not a relationship between mathematical
statements. Result of this task that the students tend for an operational to a relational view of the equal sign[14], [15].

Six students see the equal sign as the computation in that the left side and the right side have the same value. The students separate the right side and the left side. The problem is how the students find the value from the number sentence $4 + \Delta = 3 + 7$. The students mostly write down in the form of 10 rather than 6. Then the other student that answers is 6 do the computation by separate the right and left side.

Then the other student understanding about the relationship from equality is while two unknown numbers are providing in these tasks. As an example, in figure 1, the student makes the wrong answer. She did not see the left side is not the same value on the right side. In this, happen for students while students approach equations from left to right, seeking closure at the end of the equation. This error is due to students’ operational view of the equal sign where the equal sign is interpreted as the answer comes the next symbol.

The result shows students misconception about the equal sign where the student does not consider the meaning of the two statements either on the left or in the right. The students argue that meaning addition is $5 + 1 = 6$ and $4 + 2 = 1$. This different case from the other research. The expectation of the researcher from the students is the differences between 1 and four can find two numbers and make equality this statement. From our interviewer the student, they say about the differences between number 1 and four, but they do not see equality. The equality is still a problem and difficulties of the student making the true mathematical statement.

The risk of the student understanding in equivalence and equality can we see in the next topic in solving the equation in one variable. The students lead to finding the value of $x$ from this question. Only five students can solve this problem. The other students have difficulties to solve this problem. Mostly their problem is during their make substitution. Here the example of the student's wrong answer.

It is also found that students cannot determine the value of $x$ where the steps of the student are incorrect, although the students get the correct answer. The student uses the distributive property but wrong in the result. The student uses $2(x - 5) = 10 - x$ whereas the result is $2(x - 5) = 2x - 10$. In the next step, the students omit $x$ on the right side and write $x$ on the left side. To find the value $x$, students omit on one side then find the value of $x$. The equality in every step of the student is not attention to the students. The student thinks about how to find the value and the answer. The concept of find the equation by using one variable is stressing how the student understands the equal sign in formally correct way [16].

4. Conclusion
Based on the result and discussion, it can be concluded that the students have difficulties while solving the algebra task for generalizing and equality. It is caused that the students cannot see the relationship between the quantities to became the generalized number. Although they have essential about algebra, they are still in trouble while solving this problem. The letters that appear in the last question making the students confuse to know the fixed number.

On other occasions, the understanding of the students in the concept of equality still becomes a problem, whereas the idea of equality will lead the students to solve the equation in the form of $a(x \pm b) = c$. If the understanding of equality is a problem, surely the next step, it will become a problem. The variation of algebra task is needed for the student either in generalizing task or equality task. It is essential for students while studying in advance algebra.

5. References
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Acknowledgments
The author thanks the teacher and students of SMP PGMI Bandung for providing the opportunity to conduct tests and interviews on algebra tasks.