

Algebraic Skills on Solving PISA Problems

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Abstract. This study aimed to describe algebraic skills of students on solving PISA problems in Change and Relationship Content. The type of this research is descriptive. The subject on this study is consisted of 40 students in class IX-1 SMP Negeri Palembang. The data was collected by a test and interview. The results of tests and interviews were analyzed based on indicators of algebraic skills as follows: (1) Applying arithmetic operations, (2) Understanding the notion of variable, (3) Understanding algebraic expressions, (4) Understanding the different meaning of the equal sign, and (5) Mathematization. The results showed that: For indicator 1 which is categorized as the good category, the students could apply arithmetic operations correctly, in enough category, they could apply arithmetic operations but they have mistake on calculations, in bad categories, the students could not apply arithmetic operations. For indicator 2 which is categorized as the good category, the students substituted the value of the variable correctly, in enough category, they have mistake on substituting the value of the variable, in the bad category, they could not substitute the value of the variable. For indicator 3 which is categorized as the good category, the students could operate algebraic expressions by giving the correct results, in enough category, they could operate algebraic expressions but they did not give correct results, while in the bad category, they could not operate algebraic expressions. For the indicator 4 which is categorized as the good category, the students could solve equations, in enough and bad categories, they could not solve equations. For indicator 5 which is categorized as the good category, they could use the formula and got the right result, in enough category, they could use the formula but they did not give the right result, in the bad category, they did not use the known formula.

INTRODUCTION

The low score of Indonesian PISA is one of the reasons why the Government of Indonesia make the changing on the curriculum from KTSP to Curriculum 2013 which expected to improve the Indonesian students' achievement in international study. It is mean that the competence of Indonesian students weak on mathematics literacy in problem-solving, critical and creative thinking in general still low [1].

The cause of low PISA is the use of problems that have characteristics as a matter of PISA in the process of learning Mathematics in Indonesia is still considered less[2]. so students are poorly trained in solving problems with characteristics such as the substance of PISA is contextual and the level of problem is higher[3,4]. Even though the PISA problem is able to attract students' interest and motivation, they have challenged to solve the problems [5]. Therefore, Indonesian students need to be accustomed to solve problems which have characteristics like PISA problems.

In the study of PISA, there are 4 contents are tested: 1) Change and Relationship 2) Space and Shape 3) Quantity and 4) Uncertainty and Data. In addition, there are 7 mathematical abilities are used in the assessment of mathematical processes in PISA: 1) Communication, 2) Mathematizing, 3) Representation, 4) Reasoning and Argument 5) Devising Strategic for solving problems, 6) Using symbolic, Formal and Technical Language and Operation, and 7) Using Mathematics Tools [6]. The context is an aspect which is related to daily life where there are problems on it. The use of context in Mathematics learning can make it easier for students to recognize problems before solving them[7]. Moreover, the mathematical context in PISA can be categorized into 4 contexts: personal, occupational, societal, and scientific.

This research will discuss about content Change and Relationship. This content is an event or event in a variety of settings. This category deals with aspects of mathematical content in the curriculum that are functions and algebra which the materials are consisted in Mathematics learning in junior high school[8].

Skill comes from the word "capable" which means the ability, skill or strength [9]. Skill refers to a person's performance in a job which can be seen from his thoughts, attitudes and behavior [10]. While the ability of mathematics is a capability that has been owned by students in solving problems or questions of mathematics. There are several mathematical abilities that students need to be possessed, one of them is the algebraic skills.

Algebra is a material which is related to the ability of algebra. To find out the algebraic skills of students, it is necessary to have the indicators are which are able to measure the algebraic skills. The indicator for measuring students' algebraic skills is the student's ability to applying arithmetic operations, to understanding the notion of the variable, to understanding the different meanings of the equal sign, to understanding algebraic expressions and mathematization[11]. In the indicator of Applying Arithmetic Operations (ARITH): the ability of students on applying Arithmetic Operation in not only operation but also application the rules. Understanding the notion of variable (VAR): students can substitute the value of variable and understand the known and unknown variable. Understanding the different meanings of the equal sign (EQS): the ability of students on solving the equation. Understanding Algebraic Expressions (AE): the ability of students on operating algebraic expression, in which operating the general number with algebraic expressions. Mathematization (MATH): the ability of students on modeling world problems into mathematical modeling, and then it can be used as the formula which is known on the problems.

Algebraic skills is one of the mathematical skills that need attention, because the ability of algebra is very important to be owned by students. This is because algebra is the gateway of all higher branches of mathematics[12]. Algebra is also very important to be mastered by students, because either implicitly nor explicitly algebra is used in the activities of daily life. In addition, knowledge and skills of algebra are also related to daily life either directly nor as a prerequisite[13,14]. That is, algebra is a prerequisite material of various materials in mathematics such as, functions, equations of lines, equations and quadratic inequalities, linear equations systems, circular equations, trigonometric equations and other materials requiring algebraic operations. Given the importance of algebraic ability to learn mathematics, NCTM emphasizes that all students are given the opportunity to learn algebra. From the explanation above, it can be said that algebra has a very important role in Mathematics, so that it makes the ability of mathematics, one of algebraic skills also has an important role in order to achieve a higher learning so that it is needed to take attention on algebraic skill of students[15].

In relation to the problems that have been described previously, this study aims to determine the ability of Junior high School students on algebraic skills at ninth grade from the result of PISA change and relationship content which is given. The results of this study is expected to obtain a picture of the algebraic skills of junior high school students at ninth grade on solving PISA problems change and relationship content.

EXPERIMENTAL

This type of research is descriptive. Descriptive research is defined as a study that describes a phenomenon or events systematically in accordance with what it is[16]. In this research, the researcher will describe the description of algebraic skills of junior high school student of ninth grade on solving PISA problem of Change and Relationship content. Thus, the descriptions and categorization of algebraic skills levels are the main targets in this study.

The first stage of this research is the researcher determines the place of research is one of junior highschool in Palembang. After the place of study is determined, the researcher determines the subject of the study. The number of the subject was 40 ninth grade students from the participated school.

RESULTS AND DISCUSSION

The subjects of the study are students of junior high school ninth grade as many as 40 students. The subject of the study followed a PISA test and an interview at the appointed time. From the results of the tests that have been conducted by the research subjects and have been examined based on scoring rubrics, researchers classify students by algebraic skills categories. As presented in the table below:

TABLE 1 Percentage of Students' Algebraic Skills

Interval	Category	Frequency	Percentage
86 – 100	Very good	5	12,5%
71 – 85	Good	10	25%
56 – 70	Enough	11	27,5%
41 – 55	Bad	10	25%
0 – 40	Very Bad	4	10%
Total		40	100%

The research results obtained, from 40 subjects obtained that the highest category is sufficient category that is equal to 27.5% as many as 11 students, then both categories and less each of 25% as many as 10 students, after which the category is very good at 12, 5% as many as 5 students and the lowest category is very less category by 10% as many as 4 students. The example of interview researcher and students which have a very good category of problem 1, and he finds the strategy correctly on solving the problem.

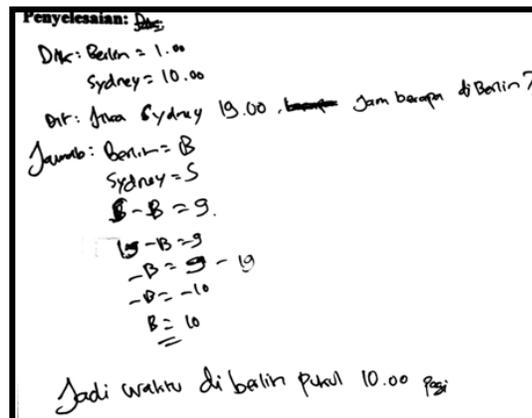


FIGURE 1. Student's answer of problem 1

- R : What is the formula you get to solve that problem ?
 S : $S - B = 9$??
 P : Well, how do you get the formula?
 S : Make symbol of Sydney become S, and then Berlyn B, see the deviation Berlyn and Sydney. The deviation is 19.
 P : after that, what will you do?
 SP1 : substitute the value of $S = 19$. Use the formula $S - B = 9$, $S = 19 - 10 = 9$, $9 = 9$

Based on the result test and interview, show that the students fulfill the algebraic skills, such as mathematization, understanding the notion of variable, understanding algebraic expressions, understanding the different meaning of the equal sign, and applying arithmetic operations. Students can find the formula correctly to solve the problem, understanding which known variable and substitute it, also can solve the equation, and he can operated general number with algebraic expressions, so he can get the result correctly.

While the achievement of the students' algebraic ability indicators can be seen in the table below:

TABLE 2. Achievement of Students' Algebraic Skills Indicators

No	Indicator	Percentage
1	ARITH	60,71%
2	VAR	75,41%
3	AE	63,75%
4	EQS	55%
5	MATH	62,14%

The highest indicator achievement is the indicator of understanding the intent of the variable (VAR) with a percentage of 75.41%, this indicator appears in questions 1, 2a, 2b, 3a, 3b, and 4 characterized by the student's ability to substitute the value of variables appropriately which known and unknown value variable. Furthermore, the indicator to understand algebraic expression (AE) has a percentage of 63.75%, this indicator appears on the question number 1, 2b and 3a, the ability of students in operating a natural number with algebraic number. Then the mathematization indicator (MATH) with a percentage of 62.14%, this indicator appears in all questions, which includes the ability to change sentences into mathematical form, find patterns or get formulas and use the formula to solve them, and also use the information already given in a matter and get the right result. Furthermore, the indicator implements arithmetic operation (ARITH) with a percentage of 60.71%, this indicator appears in all questions, in this indicator the student must be able to do sum, subtraction, multiplication or division, can follow the rules of arithmetic operations and also can solve the problem with the proper arithmetic process. Finally, the lowest indicator of achievement is the indicator. Understand the different meanings of the sign equal to (EQS) the percentage of achievement of the indicator is 55%, this indicator appears on the question number 1, 2b, 3a and 3b, on this indicator the student must be able to understand the meaning of the equal sign, which students must be solve the equations correctly

Based on the results of student tests on solving PISA problem in change and relationship content, it is known that the algebraic skills of students with the highest category is enough category 27.5%, then good and bad category 25%, very good category 12 , 5% and the lowest category is very bad category 10%. Furthermore, the percentage of each indicator, understanding the notion of variable (VAR) 75.41%, understanding the algebraic expressions (AE) 63.75%, mathematization (MATH) 62.14%, applying arithmetic operations (ARITH) 60.71 % , and understanding the different meaning of the sign equal (EQS) 55%. It means that students do not understand the different meaning of the sign is equal to 45%. The mistake the students make when solving the problem is wrong in solving the equation because the students do not understand the meaning of the same sign as the equivalence sign. Starting from elementary, junior and senior high school students are often wrong in understanding the meaning of the same sign as, Because the students do not understand the meaning of the sign equal to the equivalence of algebra or the equivalence sign[17].

The factors that cause the students are not able to solve PISA problems in change and relationship content well, the students are less accustomed in solving the problem with a lot of information. Student with bad category is wrong in determining the pattern in solving a problem. In line with Sughesty's research, who said that in general, students still have difficulties in solving problems, especially in reading the problem, that students are unable to read or recognize symbols in the matter and are not able to interpret the meaning of every word, term or symbol in the matter[18]. Another factor that makes students unable to solve the problem correctly, that is because students are not careful in understanding the information on the problem. that students have mistake in substituting the value of known variables from the problem and students mistaken in doing calculations on numbers and algebraic expressions. Reinforced with the results of research Irfan, M & Sugiman, that less accuracy, mistake and forgotten is also a factor experienced by students in solving the problem[19,20]

CONCLUSION

Based on the results of the analysis and discussion the percentage of each indicator, that is understanding the notion of the variable (VAR) 75.41%, understanding the algebraic expressions (AE) 63.75%, mathematization (MATH) 62.14%, applying arithmetic operations (ARITH) 60.71% , and understanding the different meaning of the sign equal (EQS) 55%. The following description of the algebraic skills of junior high school ninth grade on solving PISA problem in change and relationship content by category high, medium and low:

1. Algebraic skills of students with high category in solving PISA problem change and relationship content is the student able to determine the pattern or get the right formula to solve a problem by making previous symbol, able to change the sentence into mathematical form, can use the formula already known at problem and get the right result because the student can apply arithmetic operation on the numbers and algebraic expressions and also know the purpose of the variable by substituting the appropriate variable value and solving the equation.

2. Algebraic skills of students with medium category is the student is able to determine the pattern or get the right formula to solve a problem but do not make the previous symbol, still have errors in changing sentences into mathematical form, can use the formula already known in the problem but can not get the results the end is appropriate because he also still has an error in performing arithmetic operations on the numbers so that the error also in solving equations, can operate a natural language with algebraic language and can substitute the value of variables.

3. The algebra ability of low-grade students is that students can not determine the pattern or get the formula to solve a problem and also do not make the previous symbol, having an error in changing the sentence into mathematical form, can use the formula already known in the problem but can not get the final result which is precisely because it also often has errors in performing arithmetic operations on numbers and algebraic expressions, thus experiencing errors also in solving equations because it does not understand the meaning of the sign equals as a sign of equivalence, and is still mistaken in substituting the value of the variable and not knowing the value of the variable what to look for.

As for suggestions for further researchers, this research can be used as input to conduct similar research that is suggested to take data more than one class in order to give more representative result.

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