The Analyzing of Pisa-based Mathematics Problem Solving Ability based on the Algebra Learning Object

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Abstract. The aim of this study was describing the ability in solving math problems based on PISA change and relationship content based on algebra learning objects. This research was descriptive qualitative study involving 28 students of VIII B class at SMP Negeri 25 Surakarta. The techniques of collecting data used tests and interview, while the techniques of analyzing data were using data reduction, presentation, and drawing conclusions. The results of this study was the students' problem solving abilities based on four algebra learning objects according to Skemp's view, namely: 1) using symbols, 2) mathematical models, 3) linear equations and their solutions, and 4) algebraic calculations. The students with high-level math abilities were able to apply four algebra learning objects, namely: using symbols, making mathematical models, linear equations and solving them well, and the calculations correctly. The student’s weaknesses was not accurate in writing on the result of the unit obtained and there were no several symbols in giving information. The students with mid-level math abilities were only able to use symbols and create math models, the writing of the linear equations was correct but the solution was still incorrect because it was like Polya's stage, so it was not quite right because there are no calculation steps. The students with low-level math abilities were only correct in writing linear equations, the way of solving and calculating the problems were still incorrect, and the writing of mathematical models and using symbols were incorrect.

Keywords: algebra calculation, equation and solution, math model, PISA, using symbol.

1. Introduction

Education is very important thing because education can be a provision for every individual in the future. Education is a tool that can be used as a preparation for someone before facing a problem in life, both at present and in the future [1]. Tirtarahardja & Sulo explain that education is a learning activity that is taught by teachers to students which can be used as provisions before working in the form of provision of knowledge, attitudes, and skills at work [2]. Through the higher education, the opportunity to achieve something is even greater because the successful people such as entrepreneurs, company directors, and the others through an education before. The education obtained starts from parents to children in their family, education from teachers to students in the school, as well as education in society, such as behavior and attitudes among humans.

Mathematics is one of the students’ object obtained from the beginning of school to the college. Mathematics is the field of study whose branches consist of: algebra, analysis, arithmetic, and
geometry which are used to solve various problems, as a tools of thinking and communicating [3]. The characteristics of mathematic related to the way of the personal thinking and communication through the calculations or measurements in solving a problem in daily life, so that it can improve the thinking power of every human being. Everyone can use mathematics to measure something around such as objects, temperature, and others through the calculation process.

At this era, mathematic is considered difficult for some students and at the time when they go to college, they want to avoid the lessons that contain any formulas and calculations, even though almost in every department on the university must have courses related to calculation. From this statement, it is clear that almost every field of education in the university contains of mathematic subject. Even though the students memorize mathematical formulas then they never try to apply the formula, it can be useless because the formulas that are remembered may only be memorized for a moment. Mathematics is not only memorizing the formulas, but also requires application through practice to increase understanding, mastery, and can help to remember formulas and material easier that has obtained either directly from the teacher or from books or other learning media.

The problems that exist in secondary level education at this era are the test for students is not the high-order thinking skill criteria, so the students cannot think critically and the students still lacking on the thinking skills and solving the problems. According to the statement above, the students are necessary to get the HOTS questions comparable to PISA to find out whether students are able to find the solutions in solving the problems based on the problem-questions form. Based on the results of the study, the mathematics content in PISA is divided into four contents [4], [5], namely: (a) space and shape, (b) change and relationship, (c) quantity (number), (d) uncertainty and data (probability and data [6]. One of the four contents of PISA is content of change and relationship, this content is related to the subject matter of algebra learning. Basically, algebra is usually applied in daily needs problems, for example in the concept of addition, subtraction, multiplication, and division which contains several variables, denoted by letters. However, algebra is a difficult material according to the students as previously stated by previous researchers that students have difficulty understanding algebraic concepts, but can understand arithmetic concepts [7]. Skemp views learning objects related to algebraic material [8], namely: (1) use of symbols, (2) index notation, (3) calculations in algebra, (4) compiling mathematical models, equations and solutions. Students who have high-level math abilities can classify the several linear models and can identify the linear relationships between variables. Meanwhile, students with low-level math abilities cannot understand the concept of algebra, they can only express that concept in the form of images and calculation methods, so they cannot identify the relationship between variables [9]. Students with high math anxiety get errors in three ways, namely: (a) errors in writing mathematical symbols, (b) the meaning of mathematical models, and (c) inconsistencies in the use of symbols. These errors arise because the students get anxiety in dealing with mathematical situations, thus hindering problem solving [10].

There are several models in solving mathematical problems, one of the solver is Polya. According to Polya's, the model of problem-solving strategy concerns of four steps [11], there are: (a) understanding the problem (understanding the problem), (b) devising a plan (compiling a plan), (c) carrying out the plan (executing the plan), and (d) looking back. The Polya model is often used in solving the problem-based form because the model is considered to be more effective and efficient, thus making the mathematical problem is easier to solve. Based on the results of an interview with one of the mathematic teachers at SMP Negeri 25 Surakarta, the students' ability to learn mathematic in the previous era with the current one was different, because the results of the learning mathematics
at that time in his class is still relatively low. The teacher also informs that when in teaching and learning activities the students still have difficulties in understanding mathematics, especially algebraic operations, they are still confused about terms in algebra such as variables, constants, and others.

Based on the statement above, this research will be carried out with the aim of describing the ability of PISA-based mathematical problem solving based on the learning objects according to Skemp's view on the algebraic material at the VIII B students of SMP Negeri 25 Surakarta in 2019/2020 academic year. This research is important to do with the consideration in order to provide the beneficial and as a guide to improve the problem-solving abilities of students in solving PISA-based forms. In addition, this study is expected to provide an insight, especially for teachers in developing better learning by giving high-order thinking form to the students at SMP Negeri 25 Surakarta, so that the students become trained.

2. Research Method

This research used a qualitative descriptive study [12]. This research was conducted at SMP Negeri 25 Surakarta, Central Java, Indonesia. The instrument of the research was developed by conducting a validation test of the instruments forms with 2 validators (mathematics education department lecturer and mathematics teacher) [13]. The results of the test were measured based on each stage of the pattern steps with the following maximum score guidelines: understanding the problem (5 maximum score), planning strategies (5 maximum score), implementing strategies (15-25 maximum score), looking back (5 maximum score).

The technique of collecting data used the test and interview. The test involved 28 students of VIII B and the interview used 3 subjects. The subjects of this study were determined by taking one student from each group who had been divided into three levels based on the score of the test; one student from the high-level ability group (S01), one student from the mid-level ability group (S02), and one student from the low-level ability group (S03). The method of determining the three subjects was also based on recommendations of subject teachers, based on the interviews by asking which students are in the high-level, mid-level, and low-level ability groups at learning.

The Determining of the rank into three levels was based on the basic concept which stated that the distribution of student learning outcomes generally formed a normal curve, also known as a symmetric curve [14]. The benchmarks for determining the upper rank, middle rank, and lower ranking were as follows:

\[
\text{Upper rank} = \text{Means} + 1 \text{ SD} \quad \ldots (1)
\]

\[
\text{Middle rank} \quad \rightarrow \text{Means} - 1 \text{ SD} \quad \ldots (2)
\]

\[
\text{Lower rank} \quad \rightarrow \text{Means} - 1 \text{ SD} \quad \ldots (2)
\]

The techniques of analyzing data of this research used data reduction, data presentation, and drawing conclusion. This study used triangulation technique to get the data validity where the data collection was carried out by using different techniques (interviews and documentation). The documentation was obtained from the results of PISA-based student assignment, the several students who received the highest, middle, and lowest scores were selected as interviewees, then interviewing
with the interviewees who would be taken as the subjects for strengthening the information obtained as the data in this study.

The students' problem-solving abilities would be analyzed by using Polya's steps by looking at several learning objects related to algebra, including: (a) the use of symbols (understanding problems), (b) compiling mathematical models (planning strategies), (c) equations and solutions (implementing strategy), (d) calculations in algebra (implementing strategies).

3. Result and Discussion

3.1 The Results Of The Study

Based on the data analysis that researchers have conducted on the students’ assignment results and interviewed with several students and mathematics teachers, the researchers obtained the data in the form of types of the student problem solving abilities based on PISA content change and relationship.

There are some learning objects that could be the measurement of the ability of SMP Negeri 25 Surakarta students related to algebraic material based on Skemp's view [8], namely: (a) the use of symbols, (b) compiling mathematical models, (c) equations and their solutions, (d) Calculations in algebra.

Based on the research that had been done, there were some illustrations of the percentage of students' problem solving abilities based on the learning object of algebraic material according to Skemp's view at the Table 1.

| No. | The Use of Symbol | Mathematical Model | Equations and Solutions | Calculation in Algebra |
|-----|------------------|--------------------|-------------------------|------------------------|
| 1   | 27               | 20                 | 26                      | 4                      |
| 2   | 18               | 23                 | 10                      | 15                     |
| 3   | 12               | 11                 | 2                       | 0                      |
| Percentage | 67.86% | 64.29% | 45.24% | 22.62% |

The Table 1 showed the largest percentage of students' problem solving abilities was in the use of symbols of 67.86% and the lowest was in their calculation abilities, namely 22.62%, while the ability to make mathematical models was 64.29% and the ability to make equations and the solution were 45.24%.

3.1.1. S01 Troubleshooting Profile

- **Question number 1**
  The question number 1 of S01 troubleshooting profile could be displayed in the Figure 1 below:
Figure 1. The Result of S01’s Assignment Number 1

Translation of Figure 1:
1. Completion
   Understanding the Problem
2. Known:
   • an infusion at 50 drops per minute (D)
   • flowed for two (2) hours (n)
   • an infusion have 30 drops per ml (d)
3. Question: What is the volume of infusion fluid in milliliters? (v)
   • Planning Strategy
     
     Formula: \[ D = \frac{d \cdot v}{60 \cdot n} \]

   • Implementing Strategy
     \[
     50 = \frac{30 \cdot v}{60} \\
     50 = \frac{30v}{60} \\
     50 = \frac{120}{30v} \\
     50 \times 120 = 30v \\
     6000 = 30v \\
     6000 = 30v \\
     200 = v
     \]

   Based on Figure 1, S01 was able to use symbols (D, n, d, and v) correctly to change the statements contained in the questions in order to summarize and understand the problems, both known and
questioned and easy to solve the problem. The units written for each symbol were also correct. S01 was also able to compile a mathematical model and to explain the purpose of the formula used. This could be seen through the results of the interview with S01 as follows:

Researcher: Now, I ask. What is the unit of “n”?
S01: hour.
Researcher: What about “D”?
S01: D is in drops per minute.
Researcher: hour is in drops per minute, do you think to change it first? minutes to hours or hours to minutes? What do you think?
S01: I don’t think so because there is already in the number 60 in front of it.

Based on the conversation above, S01 could explain the meaning of the number 60 which was in the front of the denominator of the fraction so that the units of “D” and “n” did not need to be changed first, either “D” from minutes to hours or vice versa. S01 had been able to create and change the equations from mathematical models that had been created and the problem solving steps were correct, the way of writing of the equation in fraction form was also correct and the displacement of the left and right segments met the concept of a one-variable linear equation system. In addition, S01 had carried out the calculation process correctly and the calculation result was correct, the result was 200. S01 was still incorrect in writing the unit of the problem solving result, it should be ml (milliliters), not mm (millimeters).

- Question number 2

The question number 2 of S01 troubleshooting profile could be displayed in the Figure 2 below:

![Figure 2](attachment:image.png)

**Translation of Figure 2:**

Figure 2. The Result of S01’s Assignment Number 2
1. Completion:
Understanding the Problem

2. Known
- The installation fee is IDR 15,000,000 per lamp
- \( F = 2,000,000y - 15,000,000 \)
- \( 2,000,000y \) = profit per lamp in the Y year

3. Question: How many years of operation for each lamp take to cover the installation costs?

   - Planning Strategy
     
     Formula: \( 2,000,000y = \text{installation costs} \)

   - Implementing Strategy
     
     \[
     2,000,000y = \text{installation costs} \\
     2,000,000y = 15,000,000 \\
     y = \frac{15,000,000}{2,000,000} \\
     y = 7.5
     \]

Based on the Figure 2, S01 had been used a symbol in understanding the problem in the known part, but the description of the meaning of the symbol had not been written, for example the meaning of the symbols F and y, and S01 had written correctly what was being asked, but S01 had not included the symbol even though in the implementing strategy due to the result was denoted by the symbol y. S01 had also been able to compile a mathematical model in planning strategies to solve problems, but in the previous step, the meaning of the y symbol in the mathematical model had not been explained. Based on the Figure 2, S01 could also make and change the equations from the mathematical model that had been made and the problem solving steps were correct, the displacement of the left and right segments had fulfilled to the concept of a one-variable linear equation system. In addition, S01 had performed the calculation process correctly in order to get the correct result. The unit used to write down the results obtained was also correct, 7.5 years.

3.1.2. S02 troubleshooting profile

- **Question number 1**

The question number 1 of S02 troubleshooting profile could be displayed in the Figure 3 below:
Translation of Figure 3:

1. **Completion**

   **Understanding the Problem**

2. **Known**

   - an infusion of 50 drops per minute was delivered to the patient for 2 hours
   - an infusion have 30 drops per ml

3. **Question:** What is the volume of infusion fluid in milliliters?

   **Planning Strategy**

   Formula: \( D = \frac{d \cdot v}{60 \cdot n} \)

   Note:   
   - \( d \) = the amount of drops per ml
   - \( v \) = an infusion volume per ml
   - \( n \) = the time taken to calculate in hours

4. **Implementing Strategy**

   \[
   D = \frac{30 \cdot v}{60 \cdot 2} = \frac{30 \cdot v}{120} \\
   50 = \frac{30 \cdot v}{60.2} \\
   50 = \frac{30 \cdot v}{120} \\
   v = \frac{120}{30} \times 50 \\
   v = 40 \times 2 \times 50 \\
   v = 400
   \]
Based on Figure 3, S02 had used the symbols “D, d, and v” correctly to symbolize a statement at the stage of understanding the problem, but in symbol “D” there was no explanation yet. S02 had also been able to compile the mathematical models, but compiling the mathematical models was better if the meaning of the symbols under the formula was written at the problem of the understanding stage. S02 had used the symbol “N” and the statement used “n” even though in the mathematical model there was no “n” symbol in order to would be misinterpretation. Figure 3 could be analyzed in writing of equations and solving S02 was not in accordance with the mathematical model made, so that S02 did not understand the concept of equations. The Figure 3 could be seen that the way of writing the fraction (multiplication and division) based on the mathematical model was made in one line and was not given parentheses symbol at all which caused a double interpretation, so that the way of writing the displacement of the left and right side sections became incorrect, which could make double interpretation and the next solving step would be incorrect. In addition, S02 did not yet understand the characters that existed in the multiplication and division of integers along with the rules for displacement of the left and right segments, so the method used in calculating the algebra was incorrect and the calculation results were still incorrect, 120 ÷ 3 × 50 = 4 × 2 × 50, even though 120 ÷ 3 = 4 had been calculated, there was number 2 based on the calculation even though the result was incorrect, but in writing the unit was correct.

**Question number 2**

The question number 2 of S02 troubleshooting profile could be displayed in the Figure 4 below:

![Figure 4](image-url)

**Translation of Figure 4:**

- **Understanding the Problem**
- **Known**
  - The installation fee is IDR 15,000,000 per lamp
  - 2,000,000 = profit per year
- **Question:** How many years of operation of each lamp on the highway are required to cover installation costs?
- **Planning Strategy**
2,000,000\(y\) = installation costs

- Implementing Strategy

Debt settlement = flow magnitude \(\times\) time

\[15,000,000 = 2,000,000 \times 7.5\]

\[2,000,000 = 15,000,000\]

So the time needed to cover the installation costs is 7.5 years

Based on Figure 4, S02 had not been able to change or exemplify a sentence contained at the form into a symbol when understanding the problem. S02 used the \(y\) symbol in creating mathematical models, but in creating the math model, s02 did not provide an explanation about the meaning of the symbol. In addition, S02 had been able to compile mathematical models in planning strategies to solve the problems. Based on the Figure 4, the equation used by S02 at the stage of implementing the strategy was different from the mathematical model that had been made and the statement used was outside of the given problem, although the results obtained would also be the same as expected. In addition, the problem solving steps used were not quite right because the solution was the same as the looking back Polya stage. Even though S02 had obtained the calculation result correctly, the process used was incorrect because all the numbers were substituted, including the answer. The unit used to write down the results obtained was correct, 7.5 years.

3.1.3. S03 troubleshooting profile

Question number 1

The question number 1 of S03 troubleshooting profile could be displayed in the Figure 5 below:

![Figure 5](image_url)

**Figure 5.** The Result of S03’s Assignment Number 1
Translation of Figure 5:

- **Understanding the Problem**

**Known**
- an infusion of 50 drops per minute was delivered to the patient for 2 hours
- an infusion have 30 drops per ml

**Question:** What is the volume of infusion fluid in milliliters?

- **Planning Strategy**

**Formula:**

\[ D = \frac{d \times v}{60 \times n} = 50 \]

**Note:**
- \( d \) = the amount of drops per ml
- \( v \) = an infusion volume per ml
- \( n \) = the time taken to infuse = 2 hours

- **Implementing Strategy**

\[
\begin{align*}
D &= 30 \times v / 2.60 \\
50 &= 30v / 120 \\
v &= 120 / 30 \times 0.50 \\
v &= 4 \times 2 \times 50 \\
v &= 400 \text{ ml}
\end{align*}
\]

Based on Figure 5, S03 had used the symbols D, d, n, v correctly to represent a statement in the stage of understanding the problem, but for symbol D there was not explained. S03 had also been able to compile mathematical models, but the meaning of the symbols under the formula was better written at the problem understanding stage. Based on the Figure 5, S03 did not yet understand the concept of equations and how to write fractions (multiplication and division) based on a mathematical model that had been made in one line and did not given parentheses symbols at all which caused double interpretation, so that the way of writing the displacement of the left and right side sections became incorrect, which could make double interpretation and the next solving step would be incorrect. In addition, S03 did not yet understand the characters that existed in the multiplication and division of integers along with the rules for displacement of the left and right segments, so the method used in calculating the algebra was incorrect and the calculation results were still incorrect. Furthermore, the result could be seen in the equation (4) whereas calculating in equation (5), there were number 2, so the result was incorrect even though in writing the unit was correct.

**Question number 2**

The question number 2 of S03 troubleshooting profile could be displayed in the Figure 6 below:
Figure 6. The Result of S03’s Assignment Number 2

Translation of Figure 6:

- **Understanding Problem**
  - **Known**
    - The installation fee is IDR 15,000,000 per lamp
    - 2,000,000 = profit per year
  - **Question:** How many years of operation of each lamp on the highway are required to cover installation costs?
    - **Planning Strategy**
      - 2,000,000 = installation costs
    - **Implementing Strategy**
      - Debt settlement = flow magnitude x time
      - 15,000,000 = 2,000,000 x 7.5
      - = 15,000,000

So the time needed to cover the installation costs is 7.5 years.

### 3.2 Experimental Results

Based on the results of data analysis on the six students who were the research subjects, there was obtained a discussion of the problem-solving abilities of the students in doing on PISA-based questions on the content change and relationship. Some of the learning objects that measure students’ abilities related to algebraic material according to Skemp’s view were discussed as follows: using symbols, equations and solutions, compiling mathematical models, and calculations in algebra.
3.2.1. Using Symbol

Based on the results of data analysis, the percentage of the students' ability in using symbols was 67.86% and this ability was the highest percentage of students' problem solving abilities. The result of this research could be described that most students with high-level, mid-level, and low-level abilities were able to assume for each statement became a variable as a symbol. The students with the high-level abilities result could be seen in the S01’s assignment, the pairs between symbols and statements that explained those symbols were correct and did not cause the multiple interpretations and the written units were also in accordance with the questions. This result was in line with the research which revealed that the high-level students were able to use mathematical symbols [15]. The mid-level and low-level students could be seen from the results of the S02’s and S03’s assignment, both of them had been used symbols, but there were some symbols that had not given information to symbolize a certain statement, and the written units were in accordance with the known questions, although some of them had not given unit. There was necessary to be accuracy in writing symbols whether to use capital letters or lowercase letters so that there was no confusion which could create the multiple interpretations, for example S02 wrote the symbol "N" in mathematical models, but the explanation used “n”. The result was in line with previous research, that students were hampered in solving the problems because they got errors in writing mathematical symbols and inconsistencies in the use of symbols [10].

3.2.2. Compiling Mathematical Model

Based on the results of data analysis, the percentage of students' ability in constructing mathematical models was 64.29%, the percentage was slightly different from the ability in using symbols. Most of the high-level, mid-level, and low-level students’ abilities were partly able to make a strategy plan in the form of a mathematical model correctly, but there were some students who wrote down the multiplication and division incorrectly. These cases could make some multiple interpretations and some of the student’s variables were outside of the problems. The high-level students were able to change problems into mathematical sentences [15].

The students with the high-level abilities had been able to explain the meaning of the mathematical model that had been made, such as the meaning of the number 60 in the denominator which could be seen based on the results of the interview with S01, while the students with the mid-level and the low-level abilities had not been able to explain the meaning of the number 60. This statement was in line with the previous research which revealed that students who had high-level abilities could classify several linear models and could identify the linear relationships between variables, while students with the low-level abilities had not been able to identify the linkages between variables [9].

3.2.3. Equations and Solving

Based on the result of the research, the percentage of students' ability in making equations and solving the problems were 45.24%. In addition, based on the results of the analysis, only high-level ability students were able to make equations and solve steps well. Most of the students with mid-level and low-level abilities were already able to make equations correctly, but some of the solutions were still inaccurate because they used the looking back step by Polya. The result could be seen in the S02’s and S03’ assignment number 2.
The students with mid-level and low-level abilities could be analyzed that they did not understand the concept of a system of linear equations, so that the problem solving steps were incorrect. This result was in line with the previous research which explained that there was a relationship between students' ability to understand mathematical concepts and students' mathematical problem solving abilities [16]. Based on other research, there was revealed that students who had high-level abilities could understand the concepts between algebra, so that they could classify and identify the linear relationships between variables, while the students with low-level abilities could not understand the concept of algebra [9].

3.2.4. Calculations in Algebra

The students' ability in algebraic calculations was 22.62% and there was the lowest percentage of the students' problem solving abilities, only high-level ability students were able to perform calculations well on the easy-category questions, but in question number 1, S01 was still incorrect in writing the units of the calculation results. Meanwhile, mid-level and low-level students were still not able to do the calculation correctly due to the inaccurate displacement of the right and left segments, so the results were inaccurate, but most of them were correct in determining the unit from the calculation results. The difficulties in calculating to solve problems of linear equations could occur due to a weak understanding of basic calculations from the previous material, namely the operation of algebraic forms. The weaknesses of understanding coupled with the lack of students' thoroughness in algebraic operation questions was a big problem. This problem certainly could affect their-confidence in mathematics subjects. This result was in line with the previous research, that students tended to make a mistake in calculation, so that their completion became incorrect because the students were not careful in making calculations even though they had already understood with the questions well [16].

Based on the results of the analysis above, the researcher described that the students with high-level mathematical abilities were able to understand and able to apply four algebra learning objects, namely: using symbols, making mathematical models, linear equations and solving, and the calculating mathematic. From the result above, the students with high-level abilities had been able to solve a mathematical problem well. The weaknesses were not accurate in writing the units of the results obtained and there were several symbols that had not been given information. This result was supported by the research of Nursyahidah which showed that the profile of the problem-solving abilities of students on high-level mathematical abilities was very good, starting from understanding the problems, making plans, implementing processes and getting the correct answers [17].

The students with mid-level mathematical abilities were only able to use symbols and able to create mathematical models, the writing of the equations was correct but the solution and calculation methods were incorrect, the solving steps were the same as the Polya stage, so they were incorrect because there were no calculation steps. The students with low-level math ability were only correct in writing the equations but the solution and calculation methods were incorrect then writing mathematical models and using symbols were incorrect. This result was in line with the research of Arifin which revealed four indicators of mathematical communication skills [15], namely: solving the problems, changing problems into mathematical sentences, calculating mathematics, and using mathematical symbols. The students with high-level math abilities were able to meet the four indicators, students with moderate math abilities were able to fulfill two indicators, while students with low math abilities are only able to fulfill one indicator even though there were still errors.
The students with mid-level and low-level abilities were still weak in problem-solving steps due to a lack of practice in solving problem-based questions. This result was in line with Wulandari & Jailani’s (2018) research that students should improve their mathematical abilities to formulate mathematical situations, solve reasoning problems, interpret, and evaluate arguments [18]. In addition, this research was also supported by Rosita’s & Yuliawati’s research in 2017, based on the test of algebraic material problem-solving abilities, the low-level disposition subjects and mid-level dispositions subjects could not solve the given problem, while high-level disposition subjects were able to fulfillment all the indicators of problem solving ability not completely [19].

4. Conclusion

Based on the results of research and discussion, as well as the research objectives to describe the ability of PISA-based math problem solving, change and relationship content based on algebraic learning objects, the following conclusions could be drawn as follows: a) The students’ ability in using symbols were 67.86% and it was the highest percentage of the students' problem solving abilities, students with high-level, mid-level, and low-level abilities were mostly able to assume each statement becomes a variable as a symbol, b) The students’ ability in compiling mathematical models were 64.29%, the students with high-level, mid-level, and low-level abilities were partly able to make a strategy plan in the form of a mathematical model correctly, but there were some students who wrote incorrect multiplication and division which could make the multiple and partial interpretations and some of the students variables were outside of the problems, c) The students' ability to make equations and solve the problems were 45.24%, only high-level ability students were able to make equations and solving steps well, even though the results were incorrect, most students with mid-level and low-level abilities were already able to make equations correctly, however part of the solution was still inaccurate because it used the looking back stage by Polya, d) The students’ ability in algebraic calculations were 22.62%, it was the lowest percentage of the students' problem solving abilities in the class, only high-level ability students were able to do the calculations correctly, while the students with mid-level and low-level abilities were still unable to do the calculations correctly.

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