# An Analysis of Values in Mathematical Problem Solving in Secondary School

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Abstract : This is a descriptive qualitative study that aims to find out what values appear in problem solving learning in secondary school. The research subjects of this study are secondary school students in Palembang city. Data was collected through observation of problem solving student worksheet and was analyzed descriptively. The results show that the most dominant values that emerged at the stages of problem solving are the value of discipline, the value of relational understanding, the value of rationalism, the value of control and the value of reasoning. Otherwise, the value that are not appear at the stage of problem solving is the value of relevant knowledge and the value of objectivism. Therefore, it is advisable for teachers to optimize the material of prerequisites relate variables further.

## 1 INTRODUCTION

Getting good quality education will continue to be improved by the teacher through learning strategies that will be apply in the learning process (Parlaungan, 2008). These strategies are choose and then manage by the teacher with integration, leading students to think logically, analytically, systematically, critically, and creatively, which can help students in developing their abilities in problem solving. In order to achieve it, the teacher as an intermediary for students in achieving these abilities cannot be separate from their role in integrating values in the problem solving learning process(Aisyah, 2016). Student's mathematic values represents affective qualities develope by teachers through the mathematics materials in school (Bishop, 2008). Integrating the values in problem-solving learning helps the teacher and the students to understand the problems in order to get success in problem solving (Dollah, 2005). The values that can be developed by the teacher in the study of mathematics through problem solving are the character value, mathematical value and the value of mathematics education (Seah *et al*., 2001). Character values, mathematical values and the value of mathematics education related to the affective domain helping students to understand mathematical problems and support students to develop their thinking ability to carry out problem solving plans.

The importance of integrating these three values in problem-solving approach has not been concerned in previous learning. The teachers only used this method only to look at how students' cognition is developed in solving mathematical problems. Therefore, a deeper study on how to integrate values in problem solving learning is needed. The purpose of this study was to find out what values appear at the problem solving learning step is based on the problem solving step developed in students' worksheet. The analyzed problem-solving steps values are the step of understanding the problem devise a plan, carry out the plan, and look back (Polya, 2004).

## 2 METHOD

The type of research used by researchers was qualitative descriptive research. The subjects were tenth grade students in Senior High School Palembang, with 5 students where one student has high ability, two students who have middle ability and two students who have low ability. The object of the research was validated students problem solving worksheet developed by the researcher. It was developed by integrating the values of character such as discipline and hard work; the value of mathematics education such as relevant knowledge and reasoning; mathematical values such as objectivism, rationalism



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and control (Seah & Bishop, 2000). The data collection included the documentation with the problem solving worksheet and the observation of completing problem solving worksheet process. The researchers act as the main instrument for data collection assisted by additional instruments in form of the field notes and check lists.

Table 1: Analysis of value in mathematical problem solving.

| Step of Problem Solving | Explanation | Values |
|---|---|---|
| Understanding the Problems | Students could identify problems sequentially by writing down the known information to help solve problems<br>Students could interpret stated problems to be resolved<br>Students could collect unknown information appeared in the problem students tried to summarize the information read | Discipline |
| Planning the Problem Solving Strategy | Students could make mathematical symbols correctly<br>Students understood the chosen mathematical symbols | Objectism |
| Executing the Strategy | Students could use the systems of equation with three variables concepts and principles in executing the planned strategy | Relevant Knowledge<br>Control |
| | Students could use mathematical procedures to solve the problems<br>Students could produce mathematical procedures<br>Students could use obtained schemes or structures from the results of connecting various mathematical concepts related to problem-solving | Relational understand-ing |
| Evaluating the Result | Students could generalize the mathematical procedures applied<br>Students could give reasons for the generalization they make | Reasoning<br>Rationa-lism |

The implementation of value in mathematical problem-solving was analyzed based on the appearance of the values that existed at each step of problem solving that the researchers have mapped as in Table. 1.

As the data had been analyzed with the problem solving worksheet and coded based on the rubric on Table 1, the appearance of values at each step of problem solving done by students was analyzed and presented in narrative form next.

# 3 RESULT AND DISCUSSION

The learning process was done based on the lesson plans developed by the researchers based on values in problem solving learning. The distributed worksheet contained daily life issues related to systems of equation with three variables material. During the work process, the worksheet used four stages of problem solving that must be completed by students. During the learning process, students were given problem solving problems in form of traditional fish cake orders that must be completed in accordance with the time given by the buyer.

To solve these problems, step of problem solving were used. At the step of understanding the problem, students were trained to understand the problems in daily by writing down what was stated and asked, representing the value of discipline. At the step of planning the problem solving strategy, students were first asked to change the problem into the model of mathematics using a variable, representing the value of objectivity and control. Furthermore, students were trained to make mathematical models from the problems, then solve the problems using mathematical models obtained, indicated the existence of relevant values and relational values. Last, students did a look back and made conclusions from the mathematical model made whether it is included in the definition of systems of equation with three variables, indicated the appearance of rationalism and reasoning value. Furthermore, analysis of values in problem solving was seen by paying attention to student activities while answering value-based worksheet by analyzing the values that emerge at the step of problem solving. The following is the conclusion of the researchers on the value-based worksheet analysis, presented in Table 2. Table 2 shows the values appearing while students do the work on problem solving worksheet based on the systems of equation with three variables material.

Table 2: Values that appear at the step of problem solving.

| Step | Values appear | Values not appear |
|---|---|---|
| I | - | discipline |
| II | - | Objektism |
| III | Control and relational understanding | Relevant knowledge |
| IV | Rationalism and reasoning value | - |

Information:
I : Understanding problem
II : Planning the problem solving strategy
III : Executing the strategy
IV : Evaluating the result

1. Value of Discipline at the step of Understanding Problems

The value of discipline did not appear at the step of understanding the problem, at this stage students identified the problem sequentially by writing down the information that is known and writing down what was asked on the answer sheet, but misinterpreting the problem asked, as showed in Figure 1.

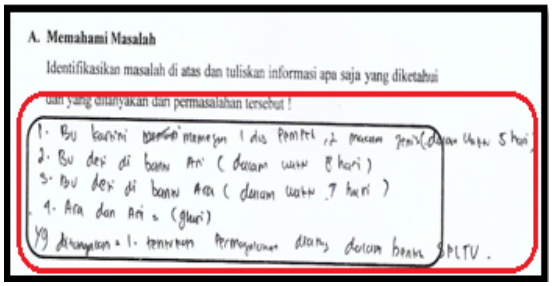


Figure 1: the answer in the step of understanding the problem for discipline value.

2. Value of Objectivity at the step of Planning the Problem Solving Strategy

Value of objectivity did not appear at the stage of planning a settlement strategy, Figure 2 below shows that students could make mathematical symbols, but did not understand the meaning of the chosen mathematical symbol. The value of objectivism almost appeared in the planning strategy for the completion, but the symbols/variables are used inappropriately according to the given problem.

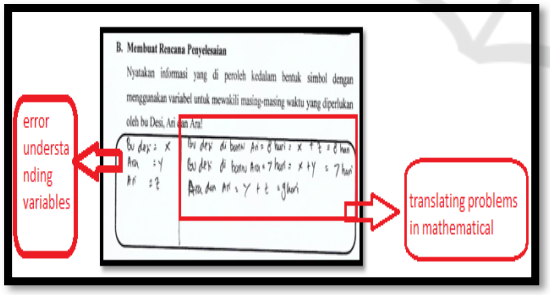


Figure 2: The answer at the stage of planning a settlement strategy for the value of objectiveness.

3. Value of Relevant Knowledge in the Step of Executing Planned Strategy

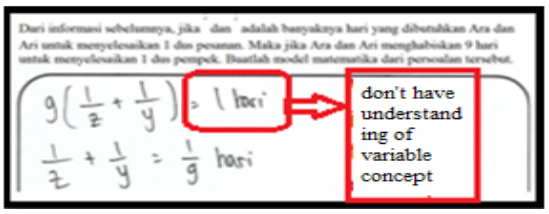


Figure 3: The answer at the stage of executing the settlement strategy for relevant knowledge values.

4. The Relevant Value at the Step of Executing the Strategy

Relevant knowledge did not appear. Based on Figure 3, it can be seen that the error was on interpreting 1 box of orders with 1 day of workmanship. Students did not use the systems of equation with three variables concept in solving the problem. It is assumed that it is because the students is not understand the meaning of the variables they make at the planning step.

5. Control Value at the Step of Executing the Strategy

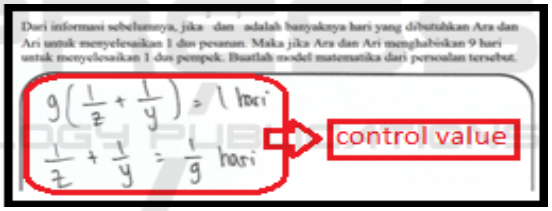


Figure 4: The answer in the run the settlement strategy stage for control values.

The value of the control appears, in Figure 4 it can be see that students carry out mathematical procedures using the concept of division to carry out the settlement strategy.

6. Relational Understanding Value at the Step of Executing the Strategy

The value of relational understanding arise when students carry out a settlement strategy, using structures obtained from the results of procedures that is carry out previously. Figure 5 below shows the emergence of relational values.

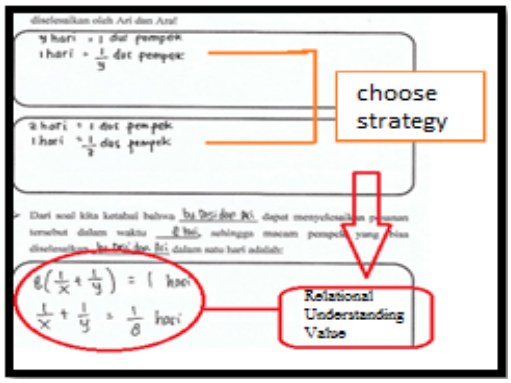


Figure 5: The answer at the stage of completing the completion strategy for the value of relational understanding.

7. Reasoning Value for the Step of Evaluating the Result

Reasoning values appear, students could generalize from the mathematical procedures obtained to lead to a conclusion. Figure 6 shows the reasoning values that is appear.

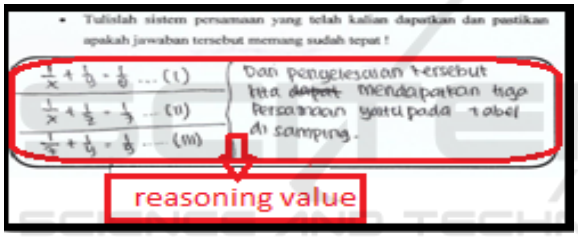


Figure 6: The answers at the checking stage for reasoning value.

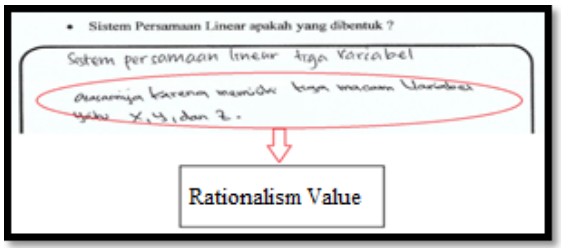


Figure 7: The answers in the Re-checking stage for rationalism values

8. Rationalism Value for the Step of Evaluating the Result

Rationalism values arise, students could give reasons (conclusions) that have been done. Figure 7 shows the value of rationalism appear.

Based on the analysis on problem solving worksheet above, the value that are not appear at the problem solving step for the category of character education is the value of discipline which is the value that students use in understanding mathematical problems, students are categorized into understanding mathematical problems if they understand from what they read and understand what they are going to solve from the problem stated. From the students' results in completing worksheet, they actually could write the information stated and write down the question asked in sequence, but are wrong in interpreting the problems stated. If the students only write "asked:", it is not enough for them to be categorized into understanding mathematical problems without understanding the presented information in the problem given. Later, it can support them to choose what strategy for solving the problem. The problems occurred due to the lack of 'ability to digest problems in this term, the story problem, also due to their faults in changing problems into mathematical situations. The results of this study are also support by research that is carry out (Sun *et al*., 2005) which results was that students' verbal abilities in digesting sentences in story problems are still low. Moreover, from the finding by (Seah & Bishop, 2000) and (Seah *et al*., 2001), it is state that students fail to solve problems because they are not have good reasoning in changing the real situation into mathematical situations.

The mathematical values appearing are the value of control and the value of rationalism, while the value that are not appear is the value of objectivism. Control value is the value that appear at the stage of carrying out the settlement strategy. The emergence of control values is discover able when students use a division procedure they are learn before in order to carry out a settlement strategy. Students who could associate prior knowledge, then students are able to solve problems (Meltzer, 2002) Students could use the knowledge they have to solve problems in worksheet that make control values appear. The value of rationalism appear at the re-checking stage, because at that stage students could give reasons for what has been written and mention the definition of the systems of equation with three variables meaning that students had already understand the definition of the systems of equation with three variables.

The value of objectivity are not appear in the planning strategy for completion, this is assume because students do not have understanding of variable concept relate to the knowledge of prerequisites in learning the systems of equation with three variables material, namely knowledge of variables, whereas knowledge of variables is need in order to solve the systems of equation with three variables problems. In the analysis of worksheet results, students could translate problems into variable forms. The variables use are not appropriate

base on the problem give, the variables x, y, and z are use for replacing the number of days use in accordance to the provisions of the problem give. Understanding the variables correctly in the systems of equation with three variables material strongly determines the outcome of the correct resolution. The results of this study are in line with the results of research conducted by (Osta & Labban, 2010) which show that students don't have good planning in a completion strategy until the stage of applying the strategy.

The values that arise in the step of problem solving in the value of mathematics education are reasoning and relational understanding, while the value of relevant knowledge are not appear. The value of relational understanding arise at the step of applying the strategy. Students are able to connect the facts state in order to solve problems. Otherwise, students are not understand the meaning of the variables used before, making their answers are not precisely good. This is in accordance with opinion (Leung *et al*., 2006) that to solve a problem, other skills such as organizing data, classifying or determining certain relationships or patterns are need so that it is possible that there are unusual ways use to solve problems.

Reasoning is that students can connect one fact with other to lead into a conclusion (Bishop, 2008) in doing this value-based worksheet. In this study, the reasoning value appear at the evaluation step. Students were able to deduce ideas from the results obtain after connecting the ideas obtain in solving problems. There are three similarities in the problem call the systems of equation with three variables.

The students are firstly expected to be able to solve problems in a real context by using value-base worksheet, but the fact showed that the value of relevant knowledge is not appear at the step of applying strategy. They are able to apply the knowledge obtain at the planning step but they make wrong in using the concepts and principles of the systems of equation with three variables when applying the solving strategy because students is not understand the meaning of the variables. According to (Ellison, 2009) the problem is give so that students can practice and think deductively, then students can see the relationship and the use of mathematics in daily, also able to master mathematical skills and strengthen the mastery of mathematical concepts.

# 4 CONCLUSION

Based on the observation analysis of value in mathematical problem solving in secondary school, it is know that some important values occurrence when students do the value-based worksheet. For the character value category, discipline values is not appear at the step of understanding problem because students cannot understand the problem correctly. For the mathematics education value category, that is not appear at the step of executing the strategy is the relevant knowledge because the students is not understand how to interpret the variables they make, and the value that appears are the value of relational understanding and the value of reasoning. For the mathematical value category that is not appear at step of planning the problem solving strategy is the value of objectivism because students do not have good understanding of variable concept related to the knowledge of prerequisites in learning of systems of equation with three variable material which is knowledge of variables, and the value that appears are value of control and rationalism.

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