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Control and rationalism value in mathematics modelling

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Abstract. Learning Mathematical modelling is an important part of mathematics. However, it is difficult to apply in learning. This research is a descriptive study with the aim of studying the learning process of mathematical modelling using worksheets (LKS) based on control and rationalism values in Junior High School Number 13 Palembang. The research subjects consisted of 37 students of class VIII.2. Data collection techniques in this study consisted of observation. Observations were made to see student activities which are appearance of control and rationalism value during the learning process and student activities using worksheets. The results of the study were obtained from student activities based on indicators of control and rationalism value during learning process with an average of 78.375 which were categorized as good result. Besides that, we observe control and rationalism value on worksheet with average of 77.79 which were categorized as good result. All learning processes use modelling stages only at the second meeting the stages of understanding the problem do not arise because the problem used continues from the problem at the first meeting so that it does not result in the emergence of control value indicators in understanding the problem.

1. Introduction

Mathematics is a very important science. Based on taxonomy Bloom's, there are 3 domains of educational objectives: cognitive, affective, and psychomotor [1]. Three domains have a synergistic relationship so that it is important in education, especially in learning mathematics. Aisyah in her research suggested that the education system in Indonesia should emphasize understanding of values [2]. The same thing stated by Sardiman said teaching and learning activities should not only be a transfer of knowledge, but also a transfer of values [3]. From this explanation, it can be seen that the objectives of the affective domain are an important part of learning mathematics because the affective domain objectives contain aspects of attitudes and values.

In learning mathematics, students should not only gain knowledge through subjects but also indirectly educated through the values that exist in learning [4]. Teaching approaches that bring up the value of mathematics in learning will make teaching more memorable, interesting, meaningful and useful to students because the value of mathematics will arouse a sense of beauty towards mathematics, arouse understanding of mathematics in life, and can help students master the power of mathematics better [5]. However, because of the teacher's limitation in understanding grades, it resulting that grades rarely realized in learning. Fitz Simons, Seah, Bishop & Clarkson [6] state that not many teachers understand the value of mathematics applied in learning, so this value is rarely raised in classroom learning.



According to Bishop [7], there are three types of values in mathematics learning, namely the value of general education, the value of mathematics education, and the value of mathematics. Bishop has identified three pairs of complementary mathematical values: rationalism and objectism, control and progress, and openness and mystery [7]. The value of control is a value related to the power of mathematical and scientific knowledge through established rules, facts, procedures and criteria. While the value of rationalism is a value that emphasizes argumentation, reasoning, logical analysis, and explanation. Based on the description above, it can be seen that the value of control and the value of rationalism are important to be raised in learning because the emergence of values in learning will arouse a sense of beauty and understanding the meaning of mathematics.

To bring up value in mathematics learning, mathematical modelling is used. This is in line with the opinion of Martin [8] states that "showed how values could enter into the mathematical modelling process". Learning with mathematical modelling can be used as one of learning in bridging abstract mathematical concepts with real world problems. This is consistent with what was expressed by Pitriani and Lee [9-10] that solving contextual mathematical problems required mathematical modelling of concrete problems leading to abstract models. Problems faced in learning mathematics are usually expressed in the form of story problems, then resolved through experiences that actively involve students. The method that is considered relevant and can bridge students to be able to understand and solve abstract mathematical problems is to use mathematical modelling [11-13]

Ang defines mathematical modelling as "representing real world problems in mathematical terms in an attempt to understand and finding solutions to the problems" [14]. That is, in mathematical modelling, real world problems are presented as mathematical models using mathematical symbols.

Mathematical modelling is the translation of real problems that have been identified into mathematical symbols or languages, the modelling process can be translated from real world phenomena or problems into mathematical problems [15-17]. Mathematical modelling is a process of thinking and the process of describing a mathematical relationship with real-world problems that are considered difficult becomes easier and clearer by pouring in the form of models or pictures [11]. The modelling process aims to simplify a problem so that it is more easily understood by students [9].

Mathematical modelling should begin to be applied in the learning process although according to Blum in its implementation mathematical modelling is still considered difficult to be applied by teachers to students in schools [18]. One effort to help facilitate the value of mathematics modelling in the learning process using worksheets because the values are reflected in the teaching-learning material, learning process, problems, and mathematical solutions [19-20].

2. Method

This research is a descriptive study with the aim of knowing the learning process of mathematical modelling using worksheets based on control values and rationalism values in SMP Negeri 13 Palembang. The study was conducted in class VIII.2 of SMP Negeri 13 Palembang in the odd semester of 2015 consisting of 37 students.

The research for 1 Basic Competence took place in 4 meetings: 3 times learning process and 1 test. But in this article only focus on 2 interrelated learning process meetings. So, data collection technique used in this study was only observation. Observations were made to see student activities which are appearance of control and rationalism value during the learning process and student activities using worksheets. Observation is carried out during the learning process, which is from the beginning of the activity until the teacher closes the lesson. Observation is used to see student activities during the modelling learning process uses an observation sheet that contains indicators of the value of control and the value of rationalism in learning mathematics modelling. Meanwhile, observations is used to see student activities using worksheets are seen from the results of student work discussions using worksheets.

3. Result and Discussion

The learning process is done based on the lesson plan that has been made in accordance with the value of control and the value of rationalism in learning mathematics modelling. The learning process begins with the researcher distributing the worksheets that have been made. Worksheet is done in groups of 3

to 4 students. The worksheets that are distributed contain problems of daily life. When the work process worksheet uses five stages of mathematical modelling that students must systematically complete with group members. The steps of learning mathematics modelling carried out in each meeting are basically the same, the differences are in the learning material and the problem.

Before the worksheet is used in the learning process, first, the worksheet is validated to a modelling expert, Dr. Yusuf Hartono as FKIP Unsri and Nadiah, S.Pd lecturers as alumni of FKIP Unsri students. The problem before being validated is in the form of the length of the shortest road that can be passed by a wheelchair user and then validated according to the validator's suggestion of using gasoline for the hose time t .

This worksheet is used at the first meeting to explain and provide information about the gradient problem by using mathematical modelling steps in addition, the worksheet is also designed to bring up the mathematical values of control and rationalism. The control value in this worksheet occurs when students working on problems of daily life (NK 1), predict problem solving (NK 2), and using rules/formulas in solving problems (NK 3). Meanwhile, the value of rationalism occurs when students give arguments from the answers given (NR 1), use graphs/tables/diagrams to simplify the problem (NR 2), and draw conclusions from solving mathematical problems (NR 3). The following example is a part of the worksheet at the first meeting at the foundation stage of thinking there are values of control and the value of rationalism (Figure 1a).

b. Create Basic theory

➤ Based on your group opinion, are 40 litres of gasoline enough to arrive from Palembang Pagaralam? Explain ☺☺☺

NK 2
&
NR 1

➤ Fill the table below to get how much litre of gasoline used for t hours

Time (hours)	Gasoline's used (litre)
$t = 0$	
$t = 1$	
$t = 2$	
$t = 3$	
$t = 4$	
$t = 5$	
det	

NK 3
&
NR 2

➤ From the table above, determine how much gasoline used from $t = x$ hours

Time (hours)	Gasoline's used (litre)
$t = x$	

Based on problem in worksheet 1 (Gradient), draw a curve from the problem, used the steps. ☺☺☺

b. Create basic theory

➤ Based on group opinion, draw the curve from the problem? Explain ☺☺☺

NK 2
&
NR 1

Figure 1. Thinking foundation stage (a) worksheets meeting 1 (b) worksheet meeting 2.

Control value that appears is predicting problem solving and using rules in solving problems. Meanwhile, the value of rationalism that arises is to provide arguments from the answers given and use tables to simplify the problem. Furthermore, the conclusion of the problem at the first meeting can be used for the second meeting which is to draw graphs using modelling steps and bring up mathematical values. The following is part of the worksheet at the second meeting.

From the worksheet example at the second meeting (Figure 1b), students are expected to be able to predict problem solving (NK 2) and provide arguments from the answers they are given (NR 1) so that the value of control and rationalism will emerge at the thinking foundation stage. From the description of the worksheet above, the worksheet that is used for each meeting is using the stages of mathematical modelling is designed to bring up the value of control and the value of rationalism. However, the worksheet for the second meeting about indicators working on problems of daily life on the value of control does not appear because the problem that is given is the same as the first problem, so students are not asked to write down what is known about the problem and what is asked about the question. After worksheet -1 and worksheet -2 are made, the researcher applies it to the field.

The First meeting is regarding gradient material. In the learning process, students are given problems in the form of the volume of the bathtub increasing with time and when using worksheet given the problem of gasoline used with time. the modelling stage is used to solve these problems. In the stage of understanding the problem, students are trained to understand the problems of daily life by writing down what is known and asked which indicates the value of control. At the foundation stage of thinking, students are asked to predict from the problems known during the learning process that is "whether the tub will be fully filled before the flow of water dies" and when the use of worksheets is "sufficient with 40 L gasoline Palembang-Pagaralam distance can be reached?" Which indicates the value rationalism. Furthermore, students are trained to make modelling of problems and then solve problems using modelling that has been obtained. In the last stage students make conclusions by connecting what is predicted.

The second meeting is regarding drawing graphic material. Researchers do not provide new problems, just proceed from the problem at the first meeting so that at the stage of understanding the problem students are not required to understand the problem again, but remind the problem at the first meeting. After students are asked to remember the problem at the first meeting, the researcher asks students to predict the graph that will form on the problem which indicates the value of rationalism. Furthermore, for the stage of making equations, students do not need to remodel the equations that is created because the problems given are the same so students immediately write down the existing equations, then solve the equations by drawing graphs that indicate the existence of control values. Next, students deduce how the graphic images of these problems by connecting from predictions made. This indicates the value of rationalism.

Observation is used to see student activities during the learning process of modelling using an observation sheet that contains indicators of the value of control and the value of rationalism. Indicators of the value of control include students can work on problems of daily life, students predict problem solving, students use rules/formulas in solving problems. Indicators of the value of rationalism include students give arguments from the answers they give, students use graphs/tables/diagrams to simplify problems, and students draw conclusions from solving mathematical problems. The following observations that the researchers have made can be seen in Table 1.

Table 1. Observation result in learning process of modelling mathematics using worksheet.

Value		Meeting 1	Meeting 2	Average		Value
				Meeting	Value	
Rationalism	Indicator 1	78.37	86.48	82.425	78.375	Good
	Indicator 2	75.68	81.08	78.38		
	Indicator 3	70.27	78.37	74.32		
Control	Indicator 1	72.97	81.08	77.025	78.375	Good
	Indicator 2	64.86	81.08	72.97		
	Indicator 3	86.48	83.78	85.13		

From Table 1 the average value of the learning process during 2 meetings of 78.375 is categorized as good [1]. This means that the learning process of mathematical modelling using worksheet based on control values and the value of rationalism have been implemented well. The value of rationalism in the learning process obtained an average of 78.375, namely the indicator gives an argument of 82.425, the indicator uses graphics/tables of 78.38, the indicator makes conclusions of 74.32. The value of control in the learning process obtained an average of 78.375, namely the indicator of working on daily life problems of 77.025, the indicator predicts 72.97, the indicator uses the rules/formula of 85.13.

Observational data were obtained from the results of using worksheet. From the observation's result, researchers analyzed by counting the number of checklist indicators that appear per stage when using worksheet. Data from observations of the use of worksheet during 2 meetings in Table 2.

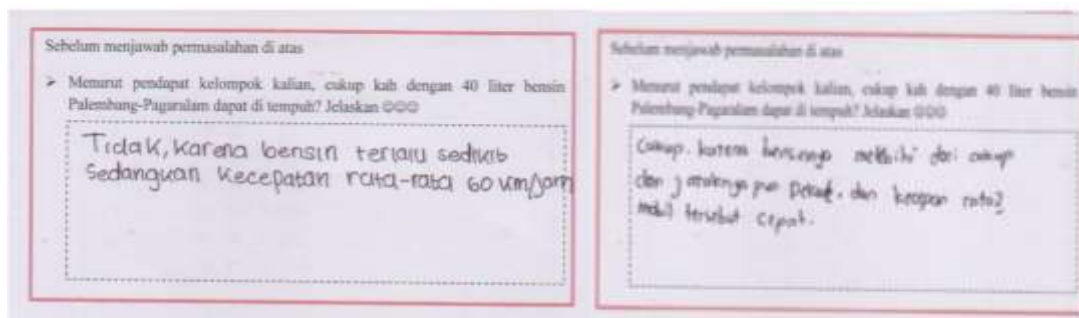
Table 2. Frequency distribution of observation results scores for worksheet use.

Stage	Meeting 1	Meeting 2	Average	Categorized
Understanding the problems	100	-	100	Better
Thinking foundation	90.59	63.33	76.96	Good
Making equation	60	100	80	Good
Completing an equation	52	96.92	74.46	Good
Making conclusion	50	80	65	Enough
Average	70.52	85.06	77.79	Good

In Table 2 it can be seen that the average value of using worksheet during 2 meetings of 77.79 is categorized as "good". This means that the use of worksheets in the learning process has been implemented well. Here's how researchers analyze student answers to obtain observational data on the use of worksheets.

The stages of understanding the problem is at the first meeting. Students do not experience much difficulty because the steps are the same as what is exemplified. All groups can understand the problem by writing down what is known about the problem and what is asked about the problem. At this stage, students begin working on daily life problems that indicate the control value.

Furthermore, in the thinking foundation stage, students begin to predict "is it enough to take 40 L gasoline for Palembang-Pagaralam distance?". Similar to the learning process, students can predict without calculating in detail the gasoline that is used. Figure 2 shows that there are 2 different opinions and different reasons from each group predictions. Out of the ten groups, there are 7 groups that make predictions "enough gasoline for Palembang Pagaralam distance" and the rest predict "not enough gasoline". From these predictions, there were 3 groups that did not give reasons, including 2 groups that answered sufficiently and 1 group that answered not enough. Here it is seen that the value of control and the value of rationalism have a relationship by showing the prediction of the problem answered along with the reason.

**Figure 2.** Student answers prediction.

After predicting the picture above, students begin to be led to make a model of existing problems with the steps that have been provided. From these steps, modelling of the gasoline used and modelling of the remaining gasoline used could be achieved. Then the next stages is making equations. The modelling results of the gasoline used and the remaining gasoline used are called the equations. At the stage of completing an equation, students can solve the equation using known equations (Figure 3).

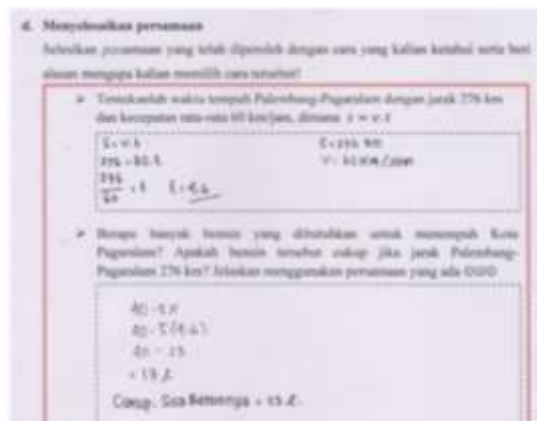


Figure 3. Stages of solving the problem.

At the stage of making conclusions, students can deduce from what is predicted and what is asked. Out Of the ten groups, only 1 group did not make conclusions, but of the 9 groups that made conclusions only 1 group connected the conclusions with the predictions made. From the first meeting, the use of student worksheets for three hours of learning or 3x 30 minutes proceeded smoothly except that the available time was not enough so that the closing time was not carried out.

In the process of using student worksheets, all indicators of the value of control and the value of rationalism emerge. So, for the first meeting all grades emerge both in the learning process and in the process of using student worksheets.

The second meeting was held on October 29, 2015 and lasted for 2 hours of learning, at the first hour and at the second hour. The activity at the second meeting, namely by directing students to sit in accordance with their group members and distributing worksheets to each group. Next, the researcher conveys the learning objectives and recalls the material that students have learned previously, namely determining the gradient. Then proceed with an explanation of the material for the second meeting which is drawing graphics. Explanation of this material also uses the stages of mathematical modelling. The stages are as follows:

At the second meeting there were no stages of understanding the problem because the researcher did not provide a new problem, only proceeding from the problem at the first meeting. So that at the stage of understanding the problem, students are not required to understand the problem again, but remind the problem at the first meeting that the volume of water tanks increases with time.

Furthermore, at the foundation stage of thinking, students are asked to remember the problems at the first meeting. The researcher asks students to predict the graph that will form on the problem according to their knowledge in the previous chapter, which is to draw relationships and functions. When students predict charts of the volume of a bathtub, there is no difference in the prediction of this problem. All students predict that the graph of the problem of the volume of a bathtub will rise to the right.

In the stage of making equations, researchers do not need to remodel the equations created because the problems given are the same so that researchers directly write down the existing equations. Then the next stage is solving the equation. From the existing equation, students are guided to fill in the tables to make it easier to make graphs. The researcher informs students that "time" is stated for the x-axis and "volume" is stated for the y-axis. With this information, students are guided to make graphs. The graph that is formed is ascending to the right. After completing the equation, students are guided to conclude how the graphs and directions are and compare with student predictions at the beginning of learning. It turned out that all students' predictions were correct that the graphic image went up to the right.

In the learning process of mathematical modelling, the value that emerges is predicting problems, using rules, giving arguments, using tables, graphs, and making conclusions. While the control value indicator that is working on daily life problems does not appear because for the second meeting the problems used are the same as the problems in the first meeting.

After an explanation from the researcher, the learning process is continued using student worksheets. Students are distributed worksheets with the problem of gasoline at the first meeting only at the second meeting continued the first problem that is drawing graphics. Students discuss with their groups to answer and find ideas/ideas with their own groups.

In the stage of understanding the problem, students no longer understand the problem only given the problems that have been made at the first meeting. At the foundation stage of thinking, After students remember the problem at the first meeting, students begin to predict graphic images and graphical directions of existing problems. Similar to the first meeting, there are two different opinions for different reasons as shown in Figure 4. All groups have made predictions, eight groups gave "decreasing" predictions and two groups giving "ascending" predictions. From these predictions, there are two groups with "decreasing" predictions giving no reason and there is one group that gives "ascending" predictions inconsistently in giving reasons.



Figure 4. Prediction of student answers at meeting 2.

Furthermore, the stages of making equations, students do not need to remodel the equation created because the problems given are the same. Students must remember the equation that was found at the first meeting and write it on the worksheet. Then the stages solve the equation. With the existing equation, students fill out tables to make it easier to make graphs. After that, students determine that "time" is stated for the x-axis and "gasoline" is stated for the y-axis and continued drawing the graph.

After getting the results, students can deduce from what was asked and predicted, it turns out that the two predictions are all true but not quite right, because no group predicts the direction of the two graphs. Out of the ten groups, only 1 group did not make a conclusion, but of the 9 groups that made a conclusion there were 6 groups that could connect the conclusions with the predictions made. The following are examples of conclusions made by students (Figure 5).

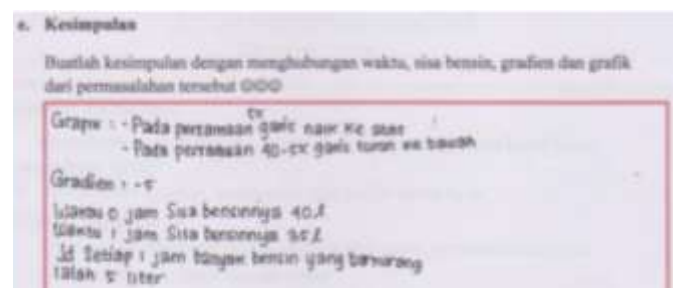


Figure 5. Conclusion of worksheet meeting 2.

In the process of using student worksheets as well as the learning process, the values that arise are predicting problems, using rules, giving arguments, using tables, graphs, and making conclusions. While the control value indicator that is working on daily life problems does not appear because for the second meeting the problem continues from the first problem so that students are not required to understand the problem again. From the second meeting, the use of student worksheets for two hours of learning or 2x30 minutes went smoothly because all stages were carried out

In learning mathematics, students should not only gain knowledge through subjects but are indirectly educated through the values that exist in learning [4]. Values that must exist in mathematical

values, namely the value of control and the value of rationalism. These values will appear during the learning process of mathematical modelling using student worksheets. The steps of mathematical modelling are the formulation of problems, the development of ideas, the formulation of mathematical models, the solutions, and the interpretation of solutions [14].

Each value has 3 indicators that appear in learning mathematical modelling. Indicators of the value of control are working on problems of daily life, predicting problem solving, and using rules/formulas in solving problems. While the indicator of the value of rationalism is to provide arguments from the answers given, use graphs/tables/diagrams to simplify the problem, and draw conclusions from solving mathematical problems. The six indicators are seen in the steps of mathematical modelling.

4. Conclusion

The learning process uses the stages of mathematical modelling consisting of understanding the problem, the foundation of thinking, making equations, solving equations, and making conclusions. The results showed that the activities of students during the learning process with an average of 78.375 were categorized as good and student activities using worksheet with an average of 77.79 which were categorized as good. All learning processes use modeling stages only at the second meeting the stage of understanding the problem does not arise because the problem is used to continue from the problem at the first meeting so that it does not result in the emergence of control value indicators in understanding the problem.

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