Enhancing vocation students physics problem-solving skills through modeling instruction applying on the direct current circuit

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Abstract. The aim of this research was to obtain about vocation students physics problem-solving skills, increasing as the effect of modeling instruction applied in physics learning. The quasi-experiment method was used with the randomized control group pretest-posttest design. The research was conducted on the students in grade X at one of vocation school in Pekanbaru city that was choice with random sampling technique. An experimental class and one controller class selected with 33 students both of them. Experiment class gets modelling instruction treatment, while control class only gets conventional model. Problem solving skills data was collected by using problem-solving skills test instrument in the essay. The result showed that applying modeling instruction in physics learning can increasing physics problem-solving skills than a conventional model with experiment class N-Gain (0,58) is greater than control class N-Gain (0,32). Consequently, it was concluded that applying of modeling instruction in direct current circuit learning is more effective for increasing physics problem-solving skills than conventional models.

1. Introduction

Physics is a science that has a very important role and involvement in the development of science-technology for our lives, whether it is related to energy, communication and even security that continues to live, grow and grow [1]. One of the subjects in SMK is Physics. Learning in SMK not only focuses on the affective, cognitive aspects but also emphasizes the psychomotor aspect. Psychomotor aspects should be trained in accordance with actual conditions in the field of work so that students are not awkward again when it has finished carrying out education and enter the world of industry [2]. Physical learning should consider the balance between the cognitive, psychomotor and affective aspects. The balance between the affective, cognitive, and psychomotor aspects are not obtained instantly, it takes learning activities that are able to provide the ability to comprehend and the ability to solve the problem well. If the student is able to correctly answer all questions related to the same concept, then the student has understood a concept well [3]. After the students are able to understand the concept well, it is expected that students should also be able to apply the concept in solving problems, especially in a physics lesson, better able to solve the problems of daily life. According to Walsh et al the ability to solve complex problems by applying students' knowledge and understanding to everyday life is one of the goals of physics learning [4]. However, the breadth of understanding and problem-solving skills that students are expected to have, is not yet fully achieved. When students are given some problems,
students tend to solve the problem with mathematical equations but have difficulty in applying mathematical equations to answer other questions that form the application of concepts to find solutions of a problem. Students are also very weak in solving problems that are contextual or issues in everyday life. Based on preliminary study, the weakness of the ability to solve problems in physics on the students learning process occurs because applied by teachers lacking provisions the ability to troubleshoot problems. How much can be done to solve the problems of physics capabilities provisions students are learning, modeling. Modeling learning has activities that are quite scientific and interesting, namely the stage of investigation and modeling stage. After the teacher gives the phenomenon, the students then investigate the phenomena, then the results obtained from the investigation are made in the form of the model. Models made can be images, graphics, mathematical equations, and verbal forms [5]. One of the forms of modeling learning is Modeling Instruction.

Modeling Instruction is one of the models of scientific learning that emphasizes active students to organize their knowledge, develop scientific science concept models, check the correctness of the model, revise the model, and then apply it to solve the problems encountered [6]. Modeling Instruction is a pattern or instructional design that has stages, where there are two stages of learning implementation that begins with the development model stage, which consists of three parts, namely pre-laboratory observation, lab investigation, and post-lab discussion), followed by activities in the second stage of the deployment model, consisting of four sections of worksheets, quizzes, lab practicum, and tests [7]. Before starting the modeling instruction lesson, the teacher divides the students into groups that are then given a medium-sized whiteboard. The chalkboard serves as a platform for students to present the models they have created. In the first activity of the development, the model is the discussion stage before the investigation work, at this stage, the students make observations or observations on the observed physical phenomena, and make a description of what is observed. After the students perform the observation activities, the students then conduct the activities of investigation, is the stage of data collection can be a relationship between the quantity of variables, free and bound variables and analyze the data to then made the model. The resulting model of the data can be either verbal, graphic, diagram, or it can be a mathematical equation. The next activity at the development stage is the discussion after the inquiry practice after the model is completed, the students are given the opportunity to present the model representation and discuss it in front of the class using the chalkboard that has been given. The second stage is the deployment model, starting with the assignment of problem sheets containing questions or questions relating to the concepts that have been obtained at the time of the inquiry. Problem sheets are done in groups. The next activity is giving individual quizzes. The quiz can be either a short question or a serialization related to what has been learned. The given problem sheet and quiz are useful for establishing students' learning comprehension skills by applying the model that has been produced at the lab research stage. The next activity after the teacher knows the ability of the students in the lab stage, the practicum is a laboratory-based problem-solving practice where his activity is solving problems in everyday life.

The problem is a mismatch between desire or expectation with the reality so that the desired desire can be achieved then something must be done that can solve the problem, although sometimes there are some obstacles or rules that we must follow [8]. According to Sak, problem-solving ability is one's ability to find solutions through a process that involves all the senses to acquire or gather information [9]. In physics, problem-solving skills are the ability to use the virtual material understanding capabilities of physics and mathematics that they possess [10]. The government through Kementrian Pendidikan dan Kebudayaan issue seventeen problem-solving indicators, but in this study only four indicators were selected on the basis of conformity with aspects that wants to canvassed consists of: understanding the problems faced, providing solutions to problems encountered, providing the reasons for the solution provided, and providing alternative solutions.

The purpose of this study is to get a picture of the improvement of the ability to solve the physics problems of vocational students as an effect of the application of modeling instruction in Physics learning.
2. Experimental method
The research method used was quasi-experiment with the pretest-posttest group design. Research design can be described as follows:

| Class    | Pretest | Treatment | Posttest |
|----------|---------|-----------|----------|
| Experiment | $O_1$   | $X$       | $O_3$    |
| Control   | $O_2$   | $Y$       | $O_4$    |

*Figure 1. Research design.*

Description:
- $X$ : Treatment with the application of modeling instruction learning
- $Y$ : Treatment with conventional learning
- $O_1$ and $O_2$ : Pretest Physics problems solving abilities
- $O_3$ and $O_4$ : Posttest Physics problems solving abilities

The subjects of the study were the students of class X in one of the vocational schools in the city of Pekanbaru. The sample was selected by 'random sampling' technique to obtain one experimental class and one control class with the number of students in each class of 33 people. The experimental class gets treatment in the form of application of modeling instruction while control class gets treatment in the form of application of the conventional model. The instrument used to collect problem-solving data is a test of problem-solving skills in the form of an essay test. Data analysis techniques were performed using statistical tests of pretest, posttest, and N-Gain data from the experimental and control classes by testing the similarity of two N-Gain averages between the experimental and control groups.

3. Result and Discussion

3.1. Research result
After making the process of learning and taking data, both in control class and in experiment class that uses learning modeling instruction, hence obtained the result of the mean value of prices and men of posttest value and value gain ability to solve a physics problem in each class like figure 2 below.

*Figure 2. Pretest, posttest and gain values in the control and experiment classes.*

In figure 2 shows that the average value of pretest in the controller class is 36.3 while the posttest value is 56.7, so the improvement of problem-solving ability in the control class or the gain value is 0.32 in the medium category. In Figure 1 it is also seen that the average value of pretest in the experimental class is 34.4 while the posttest value is 72.4, so the improvement of the ability to solve the physics problem of the students in the experimental class or the gain value is 0.58 in the medium category. This shows that the ability to solve the physics problems of students of SMK on the material of direct current electric circuit is greater happened in the experimental class by using instructional learning compared...
with the control class using conventional learning. Analytical results of the N-Gain ability to solve the physics problems in each indicator either in the control class or in the experimental class can be seen in table 1 below.

Table 1. Phase analysis solves physics problems.

| No | Indicator of solving physics problems                      | Control Class | N-gain | Experiment Class |
|----|-----------------------------------------------------------|---------------|--------|-----------------|
| 1  | Understand the problems at hand                          | 0,41          |        | 0,76            |
| 2  | Provide solutions                                         | 0,30          |        | 0,64            |
| 3  | Gives reasons for the solution                            | 0,17          |        | 0,50            |
| 4  | Provide alternative solutions                             | 0,32          |        | 0,28            |

Table 1 shows the results of stage analysis to solve the physics problems of vocational students. From the four stages solving the problem, the highest values in the contour and experimental classes are at the understanding stage of the problem, while the lowest grade in the controller class is at the stage of giving the reason for the given solution, but in the experimental grade the lowest value exists in the stages of providing alternative solutions. Hypothesis in this research is there is improvement of ability to solve physics problems in students who get learning modeling instruction with student which study conventionally.

The result of hypothesis testing with significance level $\alpha = 0.05$ got $t_{\text{count}} = 2.49 > t_{\text{table}} = 2.35$, meaning that there is a significant difference in physics problem solving ability in experiment class compared to problem solving ability in control class.

3.2. Discussion

After doing research and get a result like the picture 2 and table 1 above, hence improvement of ability to solve physics problem of a student of SMK on the material of Electric Circuits of Direct current is happening in experiment class with instructional modeling learning compared to control class with conventional learning. This result is in line with the research conducted by Malon, that this increase occurs because instructional learning has two important stages in the learning process, the first stage is the stage of development, where at this stage students are trained with full understanding of the material discussed through the provision of sensory and motoric stimuli in the form of presenting phenomena-phenomena of physical contextual or events and objects commonly encountered by students in daily life so that students it does not take a long time to recognize the phenomenon or objects that are present [11]. The same is also stated by Brewe, that the students in the modeling instruction class have a better concept of the conceptual structure so that the steps in solving the physics problem will be better too [12]. Through the guidance of teachers, students in the modeling instruction class to create a modeling in the form of images, graphics, or mathematical equations of the given phenomenon. Consolidation of the mastery of understanding of the taught material is done by way of discussion and conclusion together so that all students get a whole and equal understanding of a material taught by the teacher. This stage of development is very important to the ability to solve the problem of physics students because to be able to solve physics problems, students must have mastery of understanding the concept of the material or problems given.

The second stage that makes the ability to solve the problem of physics students in the modeling instruction class is greater than the conventional class is the stage of development. At this stage, the ability to solve student physics problems is solved through practicum activities that solve problems that can be encountered in everyday life so that the stages of problem-solving will be easily understood and done by the students. In line with what Gerace reveals, the ability to solve a student's physics problem depends not only on his level of ability but also on the problem of the problems experienced by the students themselves, so the ability to solve a problem is not only determined by a person's mindset but also influenced by work habits or training [13]. Once students are equipped with the ability to solve physics problems, students are given problem-solving exercises on quiz and unit tests. Quiz and unit tests are activities that can be done by the teacher to find out how far the ability to solve physics problems
that have been mastered by students. Thus, learning modeling instruction is very good for comprehending the ability to understand teaching materials and the ability to solve the physics problems of students, especially vocational students.

The value of the ability to solve the physics problem in the control class and the experimental class as shown in table 1 above is different. In the conventional class, the lowest value is at the stage of giving the reason for the given solution. This happens because at the time of the learning process conducted by the teacher in supplying the ability to understand only using the method of lectures or teacher centred without any other methods that can help students in understanding the given teaching materials, so that only some students who have the ability to good understanding who can accept the material given by the teacher, while students with the level of understanding that mediocre cannot understand the teaching materials provided by the teacher well. This is what causes the students are unable to provide the reasons that fit with the concept of physics when providing solutions to problems that are given. In line with that disclosed by Doctor, that mastery of the concept of understanding that has not been achieved as a whole will be an obstacle for students in solving physics problems it faces [14]. One of the important things in problem-solving is knowing the physics principles used in solving problems [15]. In the experimental class, the lowest value in solving the physics problem is at the stage of providing an alternative solution to the given problem. This happens because students focus on only one solution so that to provide alternative solutions, they can no longer. Another thing that causes students to be weak in providing alternative solutions is revealed when the interview is a learning habit that previously only focuses on solutions in the form of mathematical equations without any problems that demand alternative solutions. In addition, learning modeling instruction cannot directly change the learning habits of the students but must be done continuously so that students are accustomed and more experienced in solving problems with the correct stages [10]. In this study, although students are able to make modeling, it does not guarantee that students are able to provide a correct solution to the problem. Kohl found that not always modeling can necessarily make students proficient at solving problems because solving problems also depends on mastery of good concepts [16].

4. Conclusion
A good learning to solve students' physics problem is modeling instruction. Learning modeling instruction has two stages of development that is useful to supply the concept of reproduction and deployment stage to solve the problem of physics problem-solving. Providing contextual and more complex problems will help students in learning the ability to solve problems faced scientifically.

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