Multi-representation ability of students on the problem solving physics

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Abstract. Accuracy in representing knowledge possessed by students will show how the level of student understanding. The multi-representation ability of students on the problem solving of physics has been done through qualitative method of grounded theory model and implemented on physics education student of Unnes academic year 2016/2017. Multiforms of representation used are verbal (V), images/diagrams (D), graph (G), and mathematically (M). High and low category students have an accurate use of graphical representation (G) of 83% and 77.78%, and medium category has accurate use of image representation (D) equal to 66%.

1. Introduction

Physics is a branch of science that studies natural phenomena related to matter and energy. The natural phenomena are formed by the interaction of various physical quantities. Physics is a part of natural science that has certain characteristics. The Basic Physics Course I is a basic physics that equips students with basic concepts of physics on mechanics and thermodynamics. As the basic, Basic Physics I is the foundation for the advanced physics field. Similarly that nothing learned will end, learning in the various subjects will run together between subjects with each other, as well as interconnected [1].

Students as prospective physics teachers need a good understanding of the concept of basic physics materials because it is expected later can become a physics teacher who has professional competence. Given the importance of students’ understanding of basic physical materials, the mastery of concepts and the success of student learning in the basic physic supposed always to be pursued.

Students in expressing how their understanding, can be known through the representation of what is used in solving the problem solving. For students who have understood a concept of physics will not have difficulty to express their understanding in the form of various representations. Based on the results of research Kohl et al. (2015), which shows that the use of some appropriate representation, will help students in the problem solving physics [2]. Classifies students into two categories: skilled and unskilled students in solving physics problems [3].

Students who category of skilled in problem solving, are accustomed to using non-mathematical representations such as charts, graphs, and diagrams. While students who category of less skilled in problem solving, tend not to use non-mathematical representation. Students have a habit of using mathematical solutions in solving a physical problem. This is relevant to the assertion that the most widely used representation of students in physics problem solving is the representation [4]. The learning system tends to approach mathematics, so learners get stuck in math habits without understanding the concept of physics [5].
The multi-representation capabilities of a student can be reviewed through the accuracy of multi-representation use of physics-problem solving tests. Student's skill in using multi-representation is important to know because it can be an evaluation of lecturer's performance. From the evaluation result, a lecturer is expected to plan the appropriate teaching approach. Based on the background that has been described, the purpose of this study is to describe how multi-representation capabilities to solving physics problems.

2. Methods
The research method used is qualitative research method. Data analysis techniques used are qualitative Straus and Corbin models specifically Grounded Theory research which consists of open coding, axial coding and selective coding [6]. The research was conducted at State University of Semarang. Research subjects are students majoring in Physics education semester II academic year 2016/2017. Twenty-five students are categorized based on their level of understanding into the high, medium and low categories using the Basic Physics I document which has been taken in the first semester, mean and standard deviation. Data collection using tests, interviews, and documentation. Students are given a problem-solving test that has the characteristics of multi-representation problems V, D, G, and M as many as 14 questions. Students' answers are analyzed to identify how to accurately use multi representation on problem solving on work and energy materials.

3. Result and Discussion
3.1. Accuracy of Multiple Representation on Work and Energy Problems Solving
The accuracy of multi-representation use in high, medium and low category students on each aspect of representation V, D, G, and M each has a maximum value of 100%. The multi-representation capability profile is viewed from the accuracy of multi-representation use in work and energy problem solving, shown in Table 1.

| Category | Percentage |
|----------|------------|
|           | Verbal (V)% | Figure (D)% | Graph (G)% | Mathematical (M)% |
| High      | 56         | 61         | 83         | 50           |
| Medium    | 62         | 66         | 63         | 41           |
| Low       | 55.56      | 55.56      | 77.78      | 39.58        |

Based on Table 1, on the overall representation of V can be seen that students who solve work and energy problems in the form of this representation, most have been able to use the right vocabulary and use the Indonesian language is good and correct (EYD spelling). But there are still many found, the explanation the results of the answers that are not complete and not in accordance with the physics concept. Students are still accustomed to using M representations or mathematical solutions so that in every problem-solving explanation in the form of representation V, there are still mathematical elements such as mathematical symbols as well as numbers. It can be shown from the acquisition of V percentage value for high category students is lower than the middle category students. Based on the results of research through tests and interviews, high category students mostly use mathematical representation in solving physics problems. High category students believe that every matter of physics will always be related to mathematical equations, so it must be solved by using mathematical solutions. In the D representation, the students are mostly able to write the scientific symbols/notations that correspond to the physics concept in the diagram/drawing made. Students still have difficulty to make a drawing with a geometric line. There are also some students who still have difficulty in describing the force components that work on moving objects or silence (projecting forces...
acting on objects). Acquisition of D percentage value for medium category students is higher compared to high category students. This is due to the high category students already understand the purpose of the problem, so it does not give priority to the completeness of image representation and students consider the mathematical solution is more necessary than the picture in solving the problem. Contrast the case with medium category students who stated that, the need for image representation to assist in knowing what components are contained in the problem and how the intention of problem-solving problem.

In the G representation, students tend to have difficulty to determine the exact position of variables on the axis and have difficulty writing down the variables and units on the axis completely. Students in problems solving the form of representation G must first understand how to solve problems using M representations related to the concept. Students should not only able to use some kind of representation but must be able to use multiple representations. It can be proven from the acquisition of G percentage value for high category students that is higher than the students of medium and low category. Higher category students more have the ability and accuracy in problems solving with mathematical solutions, so it can help students in the problem solving of representation G. In the M representation, the student has a habit to write down known and questioned and has been able to identify variables that are known and asked. Students are also accustomed to writing the unit for each value contained in the problem solving. There are some difficulties experienced by students that are, there are some students who are still wrong in writing formulas or equations that fit with the concept. Students tend to use mathematical solutions, but with less than maximum results. This shows that students' ability in mathematical calculation is still not maximal. The acquisition of M percentage values for high category students is higher than for middle and low category students. This is because the high category students have understood the purpose of the problem so that students are able to determine the components and equations that are will be used in problem solving.

3.2. Results of Student Problem Solving Testing on the Materials of Work and Energy
Based on the results of the analysis on the results of work and interviews conducted to several representatives of high, medium, and low category students, found some factors that affect the lack of maximum student work outcomes. Factors of cognitive ability are one of the factors that influence learning outcomes. In addition, there are also several other factors that affect the results of student learning outcomes; namely, there is a difference between self-confidence and communication skills owned by each student are categorized into categories high, medium, and low. Relevant to the statement of Taneo et al. (2015), that the factors that influence the problem-solving abilities are the attitudes of learners that include, confidence, determination, earnestness, and persistence in finding problem solving [7]. This is known during interviews conducted between researchers and students.

High category students have high communication and confidence skills. This can be seen from the students' ability to explain the results of their work and how the students understand the purpose of the problem. High category students at the interview were able to explain the problem-solving steps of solving the problem well. Students state that they have been able to understand the meaning of the problem and relate it to the concept of physics. Furthermore, students illustrate the problem of using images. After drawing, then analyze the known variables and variables being asked and determine the formula to be used to solve the problem. Students stated that they still have difficulties when understanding the problem because the language of the problem that is considered difficult to be understood to make students confused in interpreting the intent and purpose of the question.

The middle category students have a high degree of confidence in their work, but with low explanatory skills. This can be seen when students are confused when asked to explain back the results of their work and how to understand the purpose of the problem. Students have been able to identify known and questionable variables. It's just that students get confused when understanding what problems are the problem. Students in the middle category also stated that they have difficulty in
understanding the language of the problem, thus making the students difficulties when determining the equation to be used in solving the problem.

The low category students have confidence and communication is low enough, it can be seen from the ability of students in explaining the results of his work and how students understand the purpose of the problem. Students stated that they are still unable to understand the problem, but when asked to explain again what the purpose of the problem, students can explain in a coherent and true intent of the question. This explains that students are confused or incomprehensible in solving a physical problem. Students also consider the number of physical symbols that have the same shape but with different meanings. Relevant to the statement Theasy et al. (2017), that the difficulties experienced by students, among others, is the difficulty in distinguishing the symbols contained in physics [8]. Multi-representation can be used to assist students in studying the problem or a concept of physics. Murtono et al. (2014), suggests that a concept can be explained verbally, and will be more easily understood if it comes with images, mathematical equations, and graphs stating relationships between variables [9 - 10]. This is an explanation of the multi-representation function as a complement, that is between the representations of each other can be complementary to assist students in understanding the concept.

4. Conclusion
Multi-representation capabilities possessed by high, medium, and low category students each have significant differences. It can be shown from the data acquisition accuracy of multi-representation to the problem solving that is, the students with the high category have the percentage value 56% (V), 61% (D), 83% (G), and 50% (M). Students in the medium category have a percentage of 62% (y), 66% (D), 63% (G), and 41% (M). Students with low category have 55.56% (V), 55.56% (D), 77.78% (G) and 39.58% (M).

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