Students' ability to solve problems in various forms of representation on the topic of direct current electricity

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Abstract. Problem-solving skills in a test are suspected to depend on the representation of the issues presented in the test. The purpose of this study is to describe the ability of the student in solving problems in various forms of representation, especially on the topic of direct current electricity. The research was used the qualitative descriptive method. Subjects in this study students class X-1, and sampling techniques used in this study purposive sampling. Research data obtained from the results of written tests, interviews, and field notes. One-course-variant analysis result for the influence of problem representation form resulting $F = 49.35$ which was bigger than $F$ table. Percentage of student skills analysis result in problem-solving were; 67% in sketch problem representation, 63% in verbal problem representation, 51% in graphics problem representation, and 41% in table problem representation. Research result showed that students problem-solving skill belong to the fair category, and appropriate to Heller's premise of problem-solving steps. But, student visualized each problem representation form in different ways. The result can be concluded that problem representation was affecting students’ physics problem-solving skill. Student physics problem-solving skill in a sketch, verbal, graphics form, is sufficient, while in table form is low.

1. Introduction
In the era of information technology, students tend to learn everything using visuals rather than oral narratives. The ability of students in reading tends to decrease but in capturing information through images and symbols better. This phenomenon is interesting to learn especially related to the students’ skills in solving physics problems. Ibrahim, Rebello [1] and Meltzer [2] have investigated the physics problem-solving skills of novices and experts in using various representations, and the results show significant differences in how they solve problems.

In this preliminary study, we investigated student responses in solving physics problems presented with different representations. The selected problem about direct current circuit because the topic is familiar and can be presented with various representations. Problems asked students have similar issues but are presented with verbal narratives, drawings/sketches, graphs, and tables.

Initial observations have done in X-9 class students in SMA Negeri 1 Bawang through questionnaire showed that 65% of students gave perception for representation of questions in the form of images easier to understand, 58% of students stated that the representation of questions in the form of graphs often fool, 60% of students stated that the representation of questions in verbal form is difficult, and 63% of students stated the question in the form of a table is difficult to understand. The problem of this research is whether the problem representation influences students’ ability in solving a
physics problem, and how students solve the physics problem in various forms of representation of questions (verbal, sketches, graphs, and tables).

2. Methods
The approach in this research was the qualitative descriptive approach, and the method used case study. The research was conducted in SMA Negeri 1 Bawang. The subjects in this study were students of class X-1. The sampling technique used in this study was purposive sampling. This research uses data of written test and interview with the student as the research object, and field note or documentation.

The instrument on the written test is a description test, prepared according to the student's problem-solving indicator. Before use, the written test instrument must first be tested. The trial analysis includes validity, reliability, difficulty and distinguishing power. The interview guide is an instrument used by researchers when collecting data through question and answer with students.

Analysis of the effect of representation on problem-solving ability using One Path Varian Analysis, and problem-solving analysis using description solving problem-solving guideline based on problem-solving steps from Heller et al. [3].

3. Result and Discussion
Data collection in this study included problem-solving skills test, interview, and field notes in the form of recording an interview. Interviews were conducted with the aim of confirming students' work in solving physics problems on various forms of representation of questions.

3.1. Influence of problem representation form
The influence of the problem representation on the students' ability to solve the physics problem can be known from the analysis of one-way variant. The analysis results are presented in Table 1.

| Source      | SS     | df | MS      | $F_h$ | $F_{tab}$ 5% | $F_{tab}$ 1% | Conclude |
|-------------|--------|----|---------|-------|-------------|-------------|----------|
| Between Groups | 2439.65 | 3  | 956520.43 | 49.35 | 2.67        | 3.91        | Significant |
| Within Groups | 2869561.29 | 148 | 19388.927 |       | --          | --          |          |
| Total       | 2872000.94 | 151 |       |       | --          | --          | --       |

Based on Table 1 it can be seen that $F$ count is greater than $F$ table at a significant level ($\alpha$) of 5% and 1%, so Ho is rejected and Ha accepted. This means various forms of representation of problems affecting students in solving physics problems. This finding is in line with the study of vector field representations by Bollen et al stated that students have difficulty understanding various field representations including symbolic expressions, diagrams, graph and explaining conceptual meanings of field operators [4]. As shown in the study, the effect of representation is not only found in vector field problems but also in the understanding of physics as a whole. In general, the form of representation affects the ability of students to understand physics problems [5], because students do not have the correct interpretation. De Cock has also investigated three variants of test items in the format of verbal, pictorial and graphical representations, with a statement of isomorphic problems [6]. The results show that differences between verbal and graphic formats and between verbal and pictorial formats have high significance, as well as between graphics formats and the pictorial is not significantly different. The strength of this representation has also been investigated on the topic of electrical circuits for the experiment of charging and discharging capacitors [7].
3.2. Problem Solving Ability

The result of the student's ability analysis in solving the problem on various forms of representation of the problem shows that the students are more likely to understand the problem in the form of a sketch, while the problem which is considered difficult in solving it is a matter in table form. This can be seen in the percentage of scoring on each form of representation in solving the problem. The percentage of students' scores in solving physics problems in various forms of representation of problems is presented in Figure 1.

![Figure 1. Percentage of problem solving scores on different forms of problem representation](image)

Based on Figure 1 it is known that students' ability on different forms of representation of the problem has a different percentage score. The highest percentage of scores obtained a representation of questions in the form of images or sketch, while the lowest obtained representation of questions in tables. The percentage of students' scores, indicating that the representation of sketch, verbs, and graphs is moderate, while the representation of questions in the form of tables is categorized as low. The difficulty of students in switching symbolic representations to graphs in vector fields was also expressed by Bollen et al. [8]. Students fail to understand and interpret graphical representations. One of the findings in this study that has not been widely examined by previous research is the difficulty in understanding information based on table representation.

By the indicators of students' ability to solve problems, i.e., from focusing the problem, describing the problem in the concept of physics, planning a solution, executing the plan, and evaluating the solution, included in the category quite well. However, in every form of problem representation, students have different resolution steps. The difference is in Heller's first step, that is, visualizing the physics problem [9].

Physics problem solving requires the use of verbal, pictorial, diagrammatic and mathematical representation [10]. How students understand physics problems can be improved by helping students make better representations of problems [11]. Experts and novices are different in solving physics problems [12]. The expert chooses representations strategically at a specific point in the problem-solving timeline [13].

Overall, students can solve the problem well when the question is represented as an image or sketch. The high scores on image representation are due to the problems presented to be more concrete and easy to understand. The results of this study according to the findings of Sujarwanto et al [14] which states that students make image representation only if deemed necessary for solving the problem. The results of interviews and observations in the learning show that there are students who do not make image representation if the problem has been completed with the picture or problem is considered easy. Students tend to make image representations if the problem does not have an image.
Efendi and Dwikoranto [15], revealed that the results of classroom learning applied to draw exercises better than the class that applied the problem in the form of verbal. It proves that the problems in various forms of representation affect the learning outcomes as well as the ability to solve problems. Chi & Glaser [12] and de Cock [6] suggest that the character of the problem is represented by the representation of problems presented. Formation of a problem representation proceeds naturally as one attempts to understand and solve a problem [16].

The percentage of the score proves that the form of representation of the problem affects the student in solving the problem. However, for the order of acquisition of the number of scores on various forms of representation the question deviates from the sequence of students' perceptions on the observations of the verbal matter form. In the observation, 60% of students perceived that the problem in the form of verbal difficult, and make the matter in verbal form is at the second lowest rank, while the results of research state that the number of questions in the second most verbal scores. There are several possible factors that influence it: 1) the verbal question in the study is too easy to solve compared to the previous verbal matter; 2) verbal language in the research is easy to understand; 3) students are easy in recognizing the concept of verbal questions in research. Although students encounter difficulties in different representations when solving physics problems, the inclusion of problems in various representations in teaching physics would help students build their representation competencies [17].

4. Conclusion
Based on the results of this study it can be concluded that the representation of the problem affects the ability of students in solving physics problems, namely in the representation of images, verbal, graph, medium category, while the representation in the table is categorized as low. These findings can be considered in making the test of physics.

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