How to improve student’s skill on the concept dynamic electricity?

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Abstract. Dynamic electricity is a concept with variety of issues and knowledge that requires understand, reason, and verification. This study aims to describe increasing of understanding ability and argumentation skills student in dynamic electricity by implementation of model based inquiry with multi representation. The research method is quasi experiment with randomize pretest-posttest control group design. The sample of data is in 10th grade of senior high school at Tangerang Selatan. Technique of collecting data was done by understanding ability test, argumentation skills test, and questionnaire. The results of this study shows that there was significant increase of understanding ability and argumentation skills’ student which group of implemented model based inquiry with multi representation and group of implemented model based inquiry without multi representation. Student’s response is good. Based on the result, it can be concluded that implementation model based inquiry with multi representation can exercise the student’s understanding ability and propose scientific argumentation.

1. Introduction

Physics becomes a branch of science that discusses the environment and natural phenomena, including the management of natural resources and the completion of the impact of natural disasters. According to the latest curriculum in Indonesia, which is the 2013 curriculum, physics learning becomes one of the science lessons that facilitates students to master the knowledge, concept, and principle of physics. Later, physics also trains students’ thought processes to convey an argument against a phenomenon. This is in accordance with the curriculum framework of developing interpretation, argument, and conclusion about information from two or more different facts from different sources [1].

In general, Physics learning in schools focuses on the formulation and exercise of questions without understanding the concept of physics more deeply, and the lack of explanation of the benefits of physics learning in everyday life. Students who are accustomed learning to shape and find their own concepts will be easier to master and remember them for a long time. Intellectual ability will develop as one faces new experiences and while trying to overcome them will connect new knowledge with prior knowledge and build new meaning, so students will remember the concept longer [2]. The ability to understand a requirement of students to apply their knowledge in everyday life [3].

The purpose of science education is not only the understanding of scientific concepts, but also learning how to engage in scientific discourse. To achieve the implementation of scientific discourse,
the students must have the ability to argue. The concept of science as an argument is that involvement in scholarly argument must play a key role in science education [4]. In argumentation, students convey the claims that accompanied by data and theory as support of a problem. The Argumentation plays an important role in developing critical thinking patterns and adds a deep understanding of concept and idea [5].

To convey the arguments in physics learning, students must be able to master the concept well, aligning the evidence and theories that students get to support clear conclusions or predictions, and representing a phenomenon in order to serve as evidence in the argument. Representation can provide a complex explanation of the phenomenon clearly so that the arguments presented will be accepted by others [6]. Therefore, the process of learning to seek and find knowledge through observation and experience itself required by students. Learning that is able to assist students in understanding the concept and scientific argument that is inquiry learning.

There are several problems that teachers face when applying inquiry learning are: the lack of understanding of what variables will be investigated, the lack of examples of how inquiry is the learning strategy in the classroom, and the lack of opportunities for students to make connections between scientific and practice material investigations [7]. Therefore, it takes learning that is able to facilitate students to know the experiment and inquire in the laboratory like a scientist in creating a product that is Model based inquiry (MBI).

Model-based inquiry is a learning that combines scientific inquiry with a focus on creating, evaluating, and revising scientific models that can be used to understand and predict natural knowledge [8]. An important characteristic of Model-based inquiry is that students require the creation of model representation of their ideas based on a variety of phenomena, objects, or ideas. There are 5 main activities that must be done in MBI: determining general parameters (physical phenomena), organizing what we know and what we want to know (early models), generating hypotheses, seeking evidence through experimentation, and building scientific arguments. Early models are created to construct explanations / claims and predict data acquisition [9].

To facilitate students in making explanations and data acquisition and then justified explanations and supported properly, it is necessary to use multi representation. The use of multiple representations can construct high-quality arguments, since multi-representation insertion in evidence makes a strong argument for supporting opinions and constructing appropriate arguments [10]. Therefore, students need an understanding for different representations of the process and concept of science, capable of translating from a representation to another form of representation, and understanding the use of scientific knowledge representation [11]. The selection of appropriate materials for multi-representation is required with the characteristics easily delivered in the form of visual, verbal, and mathematical. In this case the material under study is dynamic electricity.

Understanding electricity is focused on current, potential difference and especially brightness of bulbs in parallel or series DC circuits [12,13]. Besides that, to understand the concept of alternating current (AC) electric and direct current (DC) electric in everyday life. The ability to understand the relationship between electrical voltage, electrical resistance, and electricity, direct current electricity law, calculate power and direct current electric energy, is needed by students. Understanding of the process of electrical occurrence allows students to explain the phenomenon of electricity in everyday life. Therefore, it takes a figure of understanding ability and argumentation skill of student of dynamic electrical concept [14].

This study aims to determine the improvement of students' physics and physics argumentation skills in dynamic electrical concept using learning model based inquiry with using multi representation.

2. Method

The research method that used in this research is quasi-experimental method. The research design that used is "Randomized Pretest-Posttest Control Group Design" which the determination is done randomly. The sample in this research is taken by "random sampling" technique. The population of
this study were all high school students, with the target population being all 10th-grade students in the same school. The sample consists of two classes, one class as a control group which is treated with model based inquiry model, and one class as experimental group which is treated using model based inquiry with using multi representation.

Data collection in this study used comprehension skills test, argumentation skill test, and questionnaire. The ability to understand tests based on Bloom's cognitive taxonomy of revision is to explain, interpret, compare, classify, and infer. This test is a multiple choice with 5 options. While the test of argumentation skills based on components of the argumentation Toulmin are claims, data, justification, and support. This test is essay. Test the ability to understand and the argumentation skills are given before and after learning.

The data-analysis technique used the t-test of two average equations. Before the t-test is done the calculation of the average score of normalized gain-hake, normality test and homogeneity test.

3. Result and discussion

3.1. The ability to understand test

The result of statistic data shows pretest, posttest, and average n-gain value of student comprehension test after application of model based inquiry using multi representation can be seen in table 1.

| Result   | Experiment Group | Control Group |
|----------|------------------|---------------|
| Pretest  | 44.75            | 48.46         |
| Posttest | 66.92            | 73.50         |
| N-gain   | 32               | 50            |

Table 1 shows that there was an increase in the understanding ability on the mean posttest score after being treated in the experimental group greater than the control group. Improved ability to understand on the average score of N-gain both classes are in the medium category. This means that during the learning model based inquiry gives the effect to improve the ability to understand students whether using multi representation or not. These results are in line study which states that there is a significant increase in students' understanding of the concept after applying this model [15].

Furthermore, the results of research ability to understand the students studied in the realm of cognitive aspects of understanding. Some aspects of the ability to understand in Bloom's revised taxonomy are to explain, interpret, compare, classify, and infer can be seen in figure 1.

![Figure 1](chart.png)

**Figure 1.** Chart of pre-test and post-test average percentage score each aspect of understanding in control group and experiment group.
Figure 1 shows that the explaining aspect experienced the highest increase. Brief explanation is carried out through several stages of the learning activity based on inquiry model, the first stage setting of the general parameters where students are expected to make appropriate claims about the initial phenomenon assisted by making representations of images and verbal. The second stage, organizing what we know and what we want to know where students formulate questions from the phenomenon specifically, then students are guided to make the initial model in the form of images. The next stage, when students seek information and data either in writing or experiment to prove the claim. Each claim submitted should be discussed with a group of friends, so that explaining activities are formed on the students. The involvement of students in dialogue along with the process of argumentation will improve the ability to think and argue about problems related to science, so that the understanding of the scientific concept of students increases [16].

Moreover, based on the picture.1 the comparing aspect experienced a lower increase. Stage learning to compute the ability to compare when students review data in different forms of representation, so that students immediately find the reasons for the difference. But when students compare the initial model with an improved model, some students do not state the reason for the model's change. Students who successfully use the model in experimental activities when understanding the change in representation. This is why the comparison aspect does not differ between the experimental class and the control class [17].

Based on the results of statistical analysis to see the effect of model based inquiry using multi representation of both groups obtained value of \( t_{\text{count}} \) value of \( t_{\text{table}}, \) that is \( 3.02 > 2.015 \) with \( \alpha = 0.05. \) This indicates that \( \text{Ha} \) is accepted which means the implementation of model based inquiry using multi representation can significantly improve the ability of students to understand on dynamic electrical material.

3.2. The argumentation skills tests
The result of statistic data shows pretest, posttest, and average N-gain value of student's argumentation skill test after implementation of model based inquiry using multi representation can be seen in table 2.

| Result | Experiment Group | Control Group |
|--------|------------------|---------------|
| Pretest| 17.25            | 18.19         |
| Posttest| 35.70          | 33.57         |
| N-gain | 42              | 36            |

Table 2 shows an increase in posttest score of argumentation skill after treatment in experiment group is greater than control group. Improved argumentation skills on the mean score of N-gain of both classes are in the medium category. This means that during the learning of model based inquiry give influence to improve student argumentation skill either using multi representation or not. This is in line with previous research that the learning that facilitates students to participate in experimental activities, involves students in constructing arguments, and increasing understanding of the concept of science [18].

Furthermore, the result of student argumentation research skill studied is Toulmin's Argument Pattern (TAP). Some components of TAP are claim, evidence, warrant, and backing can be seen in figure 2. According to figure 2, the most significant aspect of argumentation skills is claim. Then the aspects of obtaining data, the aspect of conveying justification, and the aspects of providing support. The aspect of providing support has the smallest average score among other aspects.

Increased claim aspect because there are three learning stages that trains students' ability in making claims. The first stage, in the activity of the teacher gives the initial phenomenon related to the material and students can put forward the claim against the phenomenon. In the experimental class, students make image representations of the phenomenon first and then make the right claim.
Representation is a way of thinking to predict, understand, and build scientific claims [19]. The second stage, the teacher gives brief information about the material then the students formulate the problem of the experiment in the form of one question and make the initial model of the experiment in the form of image representation. In the third stage, students formulate hypotheses to be tested in later experimental activities. Students hypothesize using verbal representation and mathematical equations. At each stage of the Model Based Inquiry using this multi representation students are trained to file claims according to the given phenomenon. This finding is supported by the statement that students who focus on making claims is a basic part of the solution of a problem [20].

Figure 2. Charts on pre-test and post-test average percentage score each aspect of argumentation skill in control group and experiment group.

After the claim, students analyze the data. In the experimental group students are asked to create graphs and mathematical equations then described in verbal form. This makes it easier for students to obtain data and analyze it. This data will be evidence to justify the claim submitted. The ability to use data to support claims is an important component of arguing and scientific conversations for students [21]. Stage learning to familiarize students to obtain the relationship between data and claims as justification in the stage construct argument (constructing an argument). Justification is used to link data with claims [22].

The low increase of students in making support is due to the implied justification of improper linking claims and data, so the supporting theories are not appropriate. At the stage of seeking the data (seeking evidence), improve the initial model, and make the argument (constructing an argument) from the experimental results. The proposed support must be strong according to the concepts and theories used. Therefore, justification should be appropriate.

Based on the results of statistical analysis to see the effect of model based inquiry using multi representation of both groups obtained value of $t_{count}> value of t_{table}$, that is $2.62> 2.015$ with $\alpha = 0.05$. This indicates that $H_a$ is accepted which means the implementation of model based inquiry using multi representation can significantly improve students’ argumentation skill on dynamic electrical material.

4. Conclusion

Based on the above explanation, this research can be concluded that implementation of model based inquiry using multi representation can significantly improve students’ comprehension ability and argumentation skill in dynamic electrical material compared with learning model based inquiry without using multi representation. Therefore, model based inquiry learning is suitable for science learning on applicative materials. In addition, learning models motivate students to be active in learning and facilitate in understanding the concept because of the multi-representation.
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