Using multiple representations model to enhance student’s understanding in magnetic field direction concepts

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Abstract. The magnetic field direction is one of the concepts in physics that need good representation ability to understand. This article presents an application of multiple representation models to help the student understand this concept. The sample that was taken using a purposive random sampling technique consisted of 62 high school students from 3 senior high schools in Purworejo. The analysis focused on the effectiveness of multiple representation models to enhance student understands in magnetic field direction concepts and level of students’ understanding. We used drawing representation (magnetic force lines and magnetic pole) and mathematics representation. Based on the analysis it can be concluded that learning by using multiple representation models effectively to enhance students’ understanding. By CRI scale also found that students did not understand the concept more than misconception.

1. Introduction
Physics is a branch of science learn about natural phenomena [1]. To facilitate the process of analysis and explanation of these natural phenomena physicists usually use various forms of representation. It seems that multi representation can be used as an approach to learning physics. The appearance of various representations in planting a concept is predicted to be can help students learn more about the concepts learned [2], [3]. This is related to each student (student or student) having specific abilities that are more prominent than other abilities. There are students who are more prominent in verbal abilities than their spatial and quantitative abilities, but there are also the opposite. To make easier unclear concept, some representations can be used. Learning with multiple representations can give more contexts in a concept for students [2]. In another study also stated that learning with multiple representation can develop the concept and build students' scientific ability[3].

According to [4] the use of multiple representations when solving problems affect students' performance in problem-solving and can be used as a way to solve abstract problems. Students' difficulties in understanding magnetic fields have been studied primarily in the concept of magnetic force [5]–[7]. Using relationships and models that are specific to magnetic phenomena [8], [9], dealing with problems solving and mathematical forms [10] and using magnetic rules in various situations [11], [12] were some difficulties.
To solve the learning problems in magnetic concept, some learning model has been developed. In the electric field concept, new learning model has been developing with active learning [13]. As the electric field, the explanation of the concept of magnetism is very close to everyday life. However, the reality is more explanation of magnetism in mathematical explanation [14], [15] than finding the concept of the magnet itself. If we return to how scientists explain the concept of magnets, then all concepts always begin with the invention (inquiry)[16], [17].

In this magnetic field concepts learning, we use a multi-representation model. The development of this model refers to the results of Carolan et al., (2008) and Tytler et al. (2013), which has developed a multi-representation framework in topic planning (I and F), involves the role of teachers and students through the representation of learning materials (S and O) [18].

In this paper, we look in detail at enhancing students' understanding of multiple representation models. We focused on how to learn the magnetic concept and explore student representation in solving problems.

2. Numerical Methods
The research design used in this study was using the randomized static group comparison design with experimental class and control class. The effectiveness of multiple representation models was tested by using a t-test with one tail. The level of student’s understanding was analyzed using CRI scale.

The population consisted of 128 senior high schools' students of Grade XII in Purworejo, Central Java, Indonesia. The sample was selected using random cluster sampling. There were 62 students who divided into experimental class (with N= 32) and control class (with N=30). Students in the experimental class were treated with multiple representation models, and those in the control class have been addressed with conventional learning.

The data obtained using test. A set of test used to know the effectiveness of multiple representation models for increasing students' understanding related to the magnetic field concept. The test consists of 15 multiple choices questions with reason adapted from the Electric and Magnetic Conceptual Test (EMCS) developed by Maloney (2007) and included a written test in the form of an essay, completed with mathematics and picture representation. The concept consists of magnetic field direction around a magnet and straight current wire in homogeny magnetic field. Example of question from indicator revealed the problem in the form of field line diagram could see in Figure 1.

![Figure 1. Example of question from an indicator of students' understanding](image)

Students are given a concept test on a magnetic field and electric force with 2 representations, drawings, and graphs (Figure 1) i.e. poles and electric field lines [19]. The result of tests used to get information about students’ ways in representations of magnetic field direction. This finding used to evaluate and reflect the implementation of multiple representation models.

3. Results and Discussion
Data of posttest score of experiment and control class were analyzed by mean difference test. This test was obtained from improving students' understanding using posttest score with t-test Independent Sample. As seen from Table 1, t value was 2.390 with degrees of freedom df = 59. With a fault rate of 0.05 and table = 2.000 so it is concluded that there is a significant difference between the experimental
class and the control class. This shows that in learning by using multiple representation models effectively to improve students' understanding.

| Table 1 | Independent sample t-test results of both treatment class |
|---------|----------------------------------------------------------|
|          | Levene’s Test   | t-test |
|          | F    | Sig  | T    | df  | Sig. (2-tailed) |
| Posttest | Equal variances assumed | .009 | .924 | 2.390 | 59 | .020 |
|          | Equal variances not assumed |   |   | 2.392 | 58.983 | .020 |

Various forms of representation also arise during the process of investigating the concept of magnetic force. The example of the student answer can be seen in Figure 2.

![Figure 2](image.png)

**Figure 2.** A graphic representation on the concept of a magnetic field around a straight current-carrying wire

Beside the effectiveness of the model, we reports in detail students’ understanding that was analyzed with CRI scale. The results can be seen in Table 2.

| Table 2 | Students’ understanding with CRI scale |
|---------|---------------------------------------|
| Question | High CRI | Low CRI |
|          | Understand the concept | Misconception | Not understand the concept |
| Magnetic field around magnet | 6 | 12 | 14 |
| Magnetic field around straight current wire | 8 | 9 | 15 |

Table 2 shown an overview of students’ conceptual understanding on magnetic field direction concepts. Based on Table 2, the biggest number of students' conceptual understanding is on the level not understand the concepts. In this level students gave right or wrong answer but with no reason. It shown that students tend to memorize than understand the concept.

From the first results found that learning with multiple representation model are more efficient for increasing students’ understanding than conventional model. This result also in line with the research conducted by [20] which concluded that multi-representation-based learning could improve
understanding of generic science concept and the ability of physics teacher candidate. Then [21] said of the mental model that multi-representation-based learning can improve the teacher's mental model. Another research on learning of magnetism has been carried out by [22] which states that experimental inquiry-based applications are necessary for providing students’ understanding of the concept of the magnetic field. The simple experiment can use a compass. From observation, student describes the direction and pattern of the magnetic field. The results of this study found that experimental inquiry-based experiments can improve students' thinking ability. This is in line with the multiple representation learning models which also conducts investigations with experiments. We also found that how student builds the conception with their own representation. From the second results also found that more students did not understand the concepts. The test question consists of problems with different representation. Concept incomprehension is found when students work on problems with picture and graphic representation. From all discussions, given multiple representations make student thinking how to find the concept and finally increasing student’s understanding. In Schonborn & Anderson's theory (2006) that the thinking process of students in learning science has three main factors, namely conceptual, reasoning, and mode representation. The ability of the representation of students is strongly influenced also by the representation of teachers in implementing learning [20], [23]. The representation is done by adjusting the characteristics of the material to be learned [23].

4. Conclusion
This study contributes to the implementation of multiple representation models for abstract concepts and optimizes students' understanding. The teacher and student activity during the implementation multiple representation models are including a good category. As well as the representation stage, students' understanding is trained through the disclosure of observations with various representations. From deep interview can be concluded that teacher should guided the student to reveal the problem in the form of field line diagram sketch and formulas as a way to train students' thinking skills.

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