Student representation of magnetic field concepts in learning by guided inquiry

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Abstract. The purpose of this study was to determine the change of student's representation after the intervention of learning by guided inquiry. The population in this research were all students who took a fundamental physics course, consisted of 28 students academic year 2016, Department of Physics Education, Faculty of Teacher Training and Education, University of Muhammadiyah Purworejo. This study employed a quasi-experimental design with group pre-test and post-test. The result of the research showed that the average of students representation of magnetic field before implementation of guided inquiry was 28,6 % and after implementation was 71,4%. It means that the student's ability of multi-representation increase. Moreover, the number of students who is able to write and draw based on experiment data increased from 10,7% to 21,4 %. It was also showed that the number of student with no answer decreased from 28,5% to 10,7%.

1. Introduction

The teaching of fundamental physics is usually presented only in abstract concepts. Students often tend to memorize physics formula oriented problem-solving strategies [1,2]. As a result, many students do not understand the whole concepts of introductory physics. Physics concepts should be part of learning a physics process [3]. The teaching of an abstract concept in learning physics is presented the physics concepts in the form of mathematics. As a result, students do not understand physics concept. They could not represent a concept with multi-representations [4]. To improve student's understanding of physics concept, teacher should apply learning strategies which engage students in active learning using inquiry.

The concept of a magnetic field is a very important in a physics. This concept is introduced to the students from elementary school until the senior high school and this concept is observed in daily life. In general, the students feel that the concepts of magnetism are as a difficult and abstract concepts [5,6]. One of the statements in Ausubel's theory is that the most important factor that influence learning is what has been known to students [9]. In this research, the real natural phenomena were observed directly by the student, and then they were actively involved in explaining observation facts/data by drawing, formulating mathematics equation, drawing of a pattern of the magnetic field and formulating the definition of concept that relate some variable.

There are many reasons to believe that multiple representations of concepts are corresponding with the ability to construct, interpret and transform between different representations that correspond to the same physical system or process play a positive role in learning physics. First, the experts often use multiple representations as a first step in a problem-solving process [7,4]. Second, students who are taught explicit by using problem-solving strategies emphasizing the use of different representations of knowledge at various stages of problem-solving, construct higher quality and complete representations and perform better than students who learn traditional problem-solving strategies [8]. Third, multiple representations are very useful in translating the initial, mostly a verbal description of a problem into a representation more suitable for mathematical manipulation [8] because the process of constructing a representation of a problem makes it easier to generate appropriate decisions about the solution process. Also, getting students to represent it in different ways helps them to shift their focus from merely manipulating equations toward understanding physics. Some researchers have argued that to understand a concept thoroughly, one needs to be able to recognize and manipulate it in a variety of representations [4].

One of learning model that can maximize the process of learning is the inquiry learning model [9]. Inquiry learning model can be defined as the intentional process of diagnosing problems [10]. In Inquiry learning model, knowledge and classroom experience must be combined with subject matter knowledge in ways that allow students to use scientific reasoning and critical thinking to develop their understanding of science.

Many educators discussed the nature of the inquiry by making use of mostly two concepts such as open inquiry and guided inquiry (Hassard, in [11]). The open inquiry was reported that this learning model did not have a significant effect on improving students' academic achievements and developing their scientific process skills [11, 12]. This is because the different interpretations between a concept by researchers restrict reform works about the scientific inquiry with a concept that is understood by the teachers [13]. According to Furtak [14], teaching with scientific method are the boundaries of the traditional method, where certain answers by the teachers are transferred to the students and the open inquiry model, the students tried to construct their own problems and discuss problem solutions. In guided inquiry model, teachers and learners play a crucial role in asking questions, developing answers and structuring of materials and cases. The usage of guided inquiry method is very important in the transition from lecturing method to other teaching methods which are less and more clearly structured for alternative solutions.

Learning activities in guided inquiry model help students to develop their individual responsibility, cognitive levels, report making, problem-solving and understanding skills. According to National Research Council [15], guided inquiry can facilitate focusing on learning and the developing certain scientific concepts. In this Learning, students still in the teachers' guidance to focus their attention on the content, because sometimes they have less suitable means for discovering scientific thinking processes [12].

The purpose of this study was to determine the student's representation after the intervention using a learning by guided inquiry and the effectiveness of a learning by guided inquiry in building student's representation. Intervention from this learning model done with involving the magnetic field phenomena on the mathematics, illustration (pattern of the magnetic field and magnetic force), and verbal representations, so hopefully will be able to bring up representations of the student with the category of "good representations".

2. Method

2.1. Research Design

In this study used the quasi-experimental design. Quasi-experiment is a research design involving an experimental approach but where random assignment to treatment and comparison groups has not been used. The design in this stage is group pre-test and post-test design

2.2. Participants
The population in this research consists of all students in the 2016 year of fundamental physics course, Department of Physics Education, Faculty of Teacher Training and Education, University of Muhammadiyah Purworejo. The number of students from whom the samples were taken is 28 students.

2.3. Procedure
The students' representation is confirmed through the procurement of essay test questions encourage them to think of magnetic field phenomena. The representation test consists of 4 questions for the definition of the magnetic field and 6 questions for the direction of the magnetic field. The questions are selected to encourage representation processing among students by transforming visual representation into verbal representation, picture and mathematical representation. The intervention in this study is done by using steps of inquiry learning.

3. Results and Discussion
The Questions regarding students' representation of the magnitude and direction of the magnetic field required the students to use their representation in transforming magnetic field phenomena to verbal and from verbal to mathematical form (calculations). Furthermore, the students are also asked to describe it as well as to perform the transformation from a verbal statement into a picture by drawing the direction.

In Figures 1 and 2 stated an analysis of the student's answer to two questions in the diagram apparent.

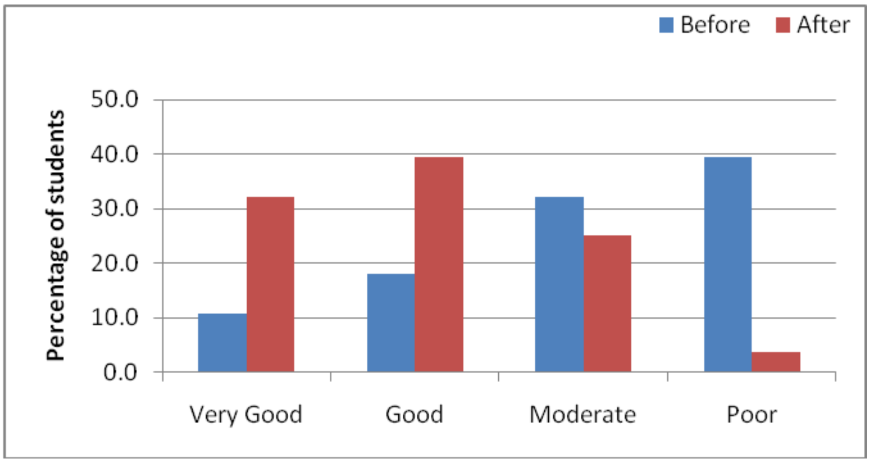

Figure 1. Graph of Student's representation on definition of the magnetic field

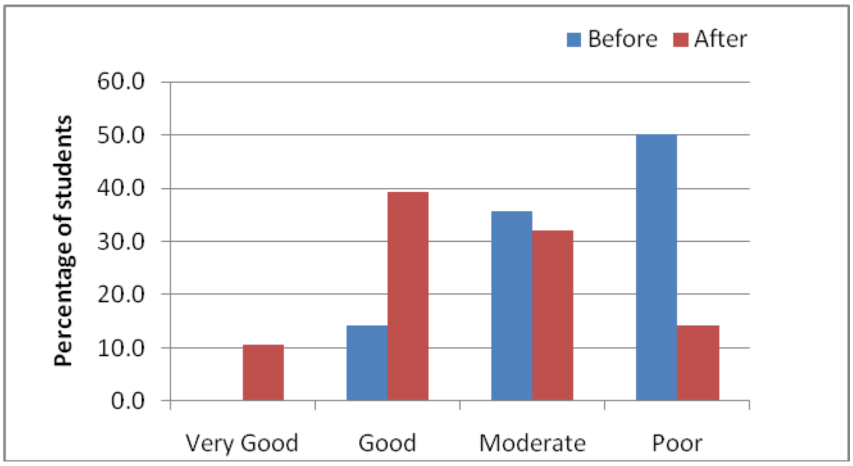

Figure 2. Graph of Student's representation on direction of the magnetic field

Based on the analysis of student's representations of the charts above, it seems like the students' representation of the magnetic field with various questions from interpretation down to verbal-to-mathematics and verbal to- picture transformations and vice versa indicate significant differences before and after the implementation of guided inquiry.

In Figure 1 and Figure 2, students who were initially unable to write the equation of magnetic field magnitude by directly translating picture from the experiment. For question 1(figure 1), the percentage of students who are able to accurately reply, interpret and transform the representation is 25% (very good), 35,7% (good) and 39,3% (moderate), whereas the remaining percentage of students still have low capabilities to interpret and transform the representation. For question 2 (Figure 2), the percentage of students with very good, good, and moderate representations are 10,7%, 39,3%, and 32,1% respectively, and the remaining students have bad representation.

Difficulties in transforming these students are the ability to interpret the direction of magnetic field in a picture; it does not appear in picture created by the students. Therefore, students need guidance and training in making representations imagination to build good understanding. Based on these results, students still have difficulty in transforming verbal to visual, although the study was conducted.

The results can also be seen from the percentage of students' ability to create images magnitude and direction of magnetic field, and write magnetic field equations directly from the experiment and the balanced equation. In Table 1 below contained more results.

Table 1. Percentage of students who can answer questions before and after the learning

No	Representation	Percentage of students (%)			
		Question 1		Question 2	
		Before	After	Before	After
1	Writing a magnitude of magnetic field equation based on fact of experiment	14,3	25	7,1	14,3
2	Drawing a direction of magnetic field based on fact of experiment	25	35,7	21,4	35,7
3	Incorrectly writing /drawing	35,7	39,3	39,3	39,3
4	No Answer	25	0	32,1	10,7

Table 1 shows that the students have been able to draw a direction of the magnetic field based on fact of the experiment, as many as 35,7% (question 1 and question 2) and these results better than before the application of guided inquiry learning, although not maximized. Not the maximal percentage of student who is can draw because students do not realize that a direction of the magnetic field or magnetic force was always perpendicular. In this case, the student just writes the equation with a direct view without settling into vector roles. These are some of the student's answer.

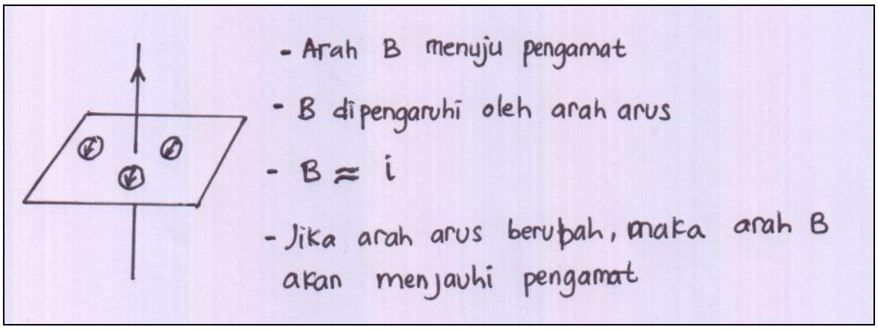

Figure 3. Sample of student's answer about direction of magnetic field with moderate category

In Figure 3 shows that the students' answers to the category of "moderate" only involve verbal representations and drawings. on the representation of the image, they have difficulty interpreting the pattern and direction of the magnetic field with the direction of the compass needle deviation. While on their verbal representation can only be concluded that the magnitude and direction of the magnetic field are only influenced by the strong electric current. in this category of students have not reached the make decisions with mathematical representations and graphics.

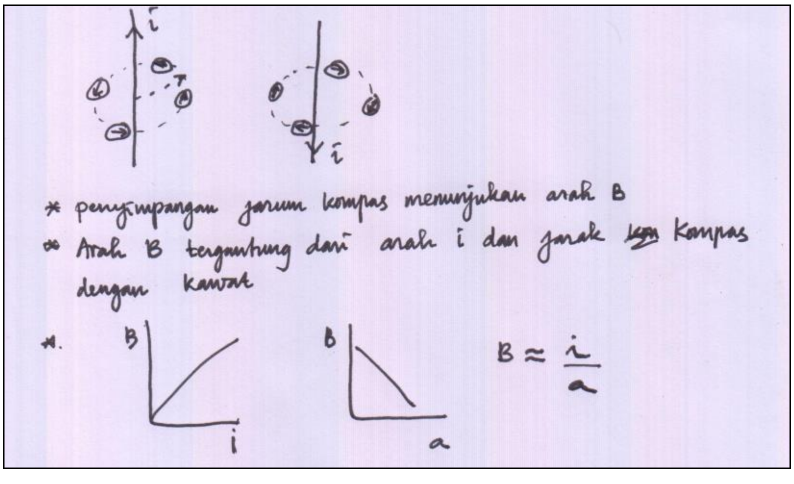

Figure 4. Sample of student's answer about direction of magnetic field with good category

In Figure 4 shows that the students' answers to the category of "very good" involving verbal representations, drawings, graphs and mathematical. the representation of their images was able to create an image with its own representation based on observations on deviation compass needle. While on their verbal representations can be concluded that the magnitude and direction of the magnetic field are not only influenced by the strong electric current, but also within the compass of the wire. Although simple, but students have also been able to represent their observations into a mathematical relationship and chart form between B, i and a.

4. Conclusion

Learning physics based on inquiry is performed with the purpose of increasing the students' analogical thinking capacity on the magnetic field by establishing a student's representation. The appearance of a student's representation reflected about his/her ability to interpret all physics phenomenon, as seen from the students' answers in verbal, mathematical or symbolic forms and picture representation. The result of this research shows that the students' representation has been well formed. In this case, before the implementation using inquiry, the students' representation was generally in the category of "poor," but after the implementation, it improved to "moderate" and "good". The establishment of students representation shows that there has been an improvement in their ability to understand the concept, as well the ability interpret and transform from the fact of an experiment to multi-representations [6,4].

This research finding shows that the learning by inquiry can be used to train the students in transforming representation. In learning the magnetic concept, the student is not only able to learn using mathematics, but also understand the direction of magnetic field and magnetic force through picture representation. Physics learning which only focuses on mathematics will result in a shallow understanding [6,16].

5. Acknowledgment

This research was supported by the Muhammadiyah University of Purworejo for facilities. The researcher thank to all institution that has been supporting this research and to the reviewers.

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