FIELDS CONCEPTUAL CHANGE INVENTORY: A DIAGNOSTIC TEST INSTRUMENT ON THE ELECTRIC FIELD AND MAGNETIC FIELD TO DIAGNOSE STUDENT’S CONCEPTIONS

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Abstract- Fields Conceptual Change Inventory (FCCI) is a diagnostic test instrument to diagnose student’s conception on the electric and magnetic field. FCCI has been developed since 2012 for surveying conceptions of students who learn Basic Physics II in Indonesia University of Education (UPI). FCCI design was based on highly desire of researchers to identify every concept on electric and magnetic field. Developing these instruments has been producing some analysis in electricity and magnetism concepts. Nowadays conceptual change is one of main issues to do research in science education especially physics education. As a consequence researchers want to diagnose conceptions of pre-service teachers on the electric and magnetic field. FCCI has been developed into two parts, the first is FCCI for diagnosing electric field and the second part is FCCI for diagnosing magnetic field. In this work authors focus on describing FCCI to diagnose conceptions of students on electric and magnetic field. As many as thirty three students have been surveyed by testing FCCI instrument in Odd Semester 2014/2015 and data was processed to analyze conceptions in some categories, those are: understanding of concept, parallel (partially) conceptions, misconceptions and do not understand of concept. Data were analyzed by using percentage and described both quantitatively and qualitatively. To sum up pre-service teachers have variety conceptions on electric and magnetic field which is very useful to be a baseline for next research.

Keywords- FCCI, Electric And Magnetic Field, Diagnostic.

I. INTRODUCTION

Nowadays misconceptions have been one of significant domain research in science education, more specific at physics education. Misconceptions among students on complex and abstract physics concept can be met worldwide. Students which experience misconception difficult to change from wrong to correct knowledge. Students’ misconception can only be converted into the correct concept next to scientific conception. If students have internal motivation to change which is known as conceptual change.

As of misconceptions, conceptual change has also become one of the most crucial research domains in the study of Science Education, especially Physics Education. The first conceptual change models, developed by Posner, et al. [1] has become the most influential theory since the beginning up to now. This conceptual model has been developed to describe the change of learning as the relationship between existing knowledge with new knowledge that leads to the four conditions, namely: dissatisfaction, clarity (intelligibility), the sensible thing (plausibility) and success (fruitfulness). Various studies as a base model on conceptual change approach involving cognitive conflict in it can be found in Ref. [2]; Ref. [3]; and Ref. [4]. Cognitive conflict strategy is more emphasis on students’ self-esteem instability (destabilizing the student's confidence) on specific concepts through experience opposites as discrepant event. All models of conceptual change approach had been proven working effectively and optimally when researchers conducted a diagnosis prior to the respondent that would be the subject of subsequent research. To solve this issue, researchers have developed an FCCI (Fields Conceptual Change Inventory) instrument in the form of three-tier test (T three). FCCI instrument consists of two core concepts, namely the electric field and magnetic field. In this article, the researchers focus on FCCI instrument to diagnose conception of pre-service physics teachers to the concept of electric and magnetic field learned in Basic Physics II.

FCCI instrument development is modified from the structure of instrument developed by Vatansever [5] that made up the instrument in format of the three-tier test semi open-ended type, whereas the development of each tier (level) has been developed and compiled in first tier of several standard tests as in [5]; [6]; [7]; and [8]. Three Tier Test organized into three levels (tiers), namely: the first tier to the standard question in the form of multiple choice with five choices, the second tier is given a blank for an explanation of the answer, and the third tier contains level of confidence (confidence rating) of the answers, namely: very confident, not confident and do not know.
II. THEORETICAL FRAMEWORK

FCCI instrument has been developed by employing 4D model, namely: 1) Defining, 2) Planning, 3) Developing and 4) Disseminating. In defining phase, researchers investigated the concept that would be put into the instrument through a case study about the spread some standard questions Ref. [5] and the resulting development of the concept of the FCCI instrument is focused on the concept of vector fields (electric and magnetic fields). In the second phase (planning), team of researchers conducted preparation and planning in determining the research subjects and course studied. Determination of physics course as the research subject by doing the analysis of the initial study (case study) result which states that the Basic Physics II is a subject which was very influential in mastering the concept of Physics for pre-service teachers. This course is conducted in the third period (3rd semester). Development phase is the core of FCCI development, that could help researchers to diagnose student conceptions related to the concept of the electric field so that the research could proceed smoothly and obtained quantitative and qualitative analysis to support the subsequent data analysis. The last phase (disseminating) performed and given to students who are enrolled in Basic Physics II course at class B on the Department of Physics Education in academic year 2014/2015. The step for FCCI development research can be seen in Figure 1.

Fig. 1. Preliminary Design of FCCI Development on Remedial Teaching

FCCI instrument on the concept of the electric field consists of 13 questions in the form of a three-tier test, all of which refer to electric field fundamental concept and another related concept within the same topic. Another FCCI instrument test has 14 problems set on magnetic field shown below is a problem of FCCI instrument on electric field (no.5):

(5). A positive charge can be put at one point in two different positions in a region with a uniform electric field, as shown below.

How is the comparison of electric force on the charge for position 1 and 2?

a. Electric force is greater at position 1.
b. Electric force is greater at position 2.
c. Electric force at position 2 is zero.
d. Electric force at both position is the same, but not zero.
e. Electric force at both positions have the same magnitude but opposite direction.

Explanation:

The level of confidence for the chosen answer:

a) Very confident b) Not sure c) Do not know

Whereas one of a problem of FCCI instrument on magnetic field (no.3) as an example is:

(3). An electron with initial velocity enters the uniform magnetic field region, with direction toward the paper. The electron velocity is perpendicular to the magnetic field direction as shown below.

Ignoring the earth’s gravity. How many forces do act on the electron when it pass?

a. One, it is the force acts on the moving electron outside the uniform magnetic field.
b. One, it is the magnetic force.
c. Two, they are the forces act on the moving electron inside the uniform magnetic field and the magnetic force.
d. Two, they are the electric force outside the uniform magnetic field and magnetic force.
e. There is no force acting on the electron.

Explanation:

The level of confidence for the chosen answer:

a) Very confident b) Not sure c) Do not know
Criteria for diagnosis of students’ conceptions on electric field topic using the FCCI are:

- Misconception (M): Tier I and Tier II are wrong and confidence rating is “very confident”
- Understanding the Concept (UC): Tier I and Tier II are correct and confidence rating is “very confident”
- Parallel Conceptions (PC): Tier I and Tier II are correct and the confidence rating is “not sure” or “do not know”
- Do not Understand the Concept (NUC): Tier I and Tier II are wrong and the confidence rating is “not sure” and “do not know”.

III. RESEARCH METHOD

A survey method was conducted to obtain the profiles of 33 pre-service physics teachers. The subject research was tested by using FCCI instrument the form of open-ended three-tier test within 50 minutes duration of lecturing. The survey was conducted prior the students learned about electric and magnetic field concept on the course of Basic Physics II.

IV. RESULT AND DISCUSSION

Conducted survey research data was the diagnostic result of a profile of student’s conceptions that contracting Basic Physics II course in the academic year 2014/2015. Quantitative data were expressed in percentages while qualitative data was obtained relevant data about the reasons for the answers on the first level. Here was a profile data of Physics student’s conception to the concept of an electric field and magnetic field that were diagnosed using the FCCI form of open-ended three-tier test such as Table 1.

Table 1. Students’ Conceptions Profile on Electric and Magnetic Field.

<table>
<thead>
<tr>
<th>No.</th>
<th>Misconception</th>
<th>Parallel Conception</th>
<th>Understanding the Concept</th>
<th>Do not Understand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>4</td>
<td>10</td>
<td>6</td>
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<td>2</td>
<td>7</td>
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<td>1</td>
<td>12</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>%</td>
<td>100=25%</td>
<td>75=19%</td>
<td>60=15%</td>
<td>105=41%</td>
</tr>
</tbody>
</table>

Table 1 shows that the conception profiles associated to pre-service teachers were in jeopardy. This is due to very low percentage (about 15%) of students who understand the concept. Furthermore, students who have misconceptions much higher than the students who understand the concept of an electric field, that is 25% relative to 15%. This data become strong "alert" in order to push change previously lecturing in Basic Physics II course to scientific conception as already described in Sekercioglu & Kocakula [9]. All experts Physics and Physics Education have agreed, when studying the concept of electricity both static and dynamic requires the concept of electric field as the embodiment of the concept of electricity itself. It will be a difficult task to understand electricity concept comprehensively, if the student does not understand the concept of electric field well. According to Serway & Jewett [10] the field concept is needed in while explaining the abstract concept of electricity and magnetism and can serve as a bridge for the concept of electricity and magnetism become more compact to be understood. Besides concept of the electric and magnetic field need special chapter for more emphasis in the study of the concept.

Quantitative data in Table 1 are supported by qualitative data come from students’ response (that is their explanation/reason) related to tier I. As an example, below is response transcription from most students associated with the no. 5 previously shown.

1. Magnitude of the electric force is influenced by both of the charges and distance between. So there is no influence of the magnetic field as long as the particles in rest.
2. Because the (−) sign means the opposite direction to that the (+) sign.
3. Because at position 1 there is electric force influence (particle will be pushed).

Based on 33 students’ transcription of tier II for every question will obtain wide variety of reasons. Starting from wide variety of students’ reasons, researchers summarize and selected the top-four alternative answers for each question. Then the reasons from those students are arranged in a semi-enclosed choice for the next development of FCCI instrument. Current structure and format of FCCI is in the form of three-tier (3-level). Next the authors will change the level II of open essays into four choices of reasons that have been prepared based on current study with additional one reason in essay format as an open alternative in case students do not choose the four options provided.

Concluding Remark

Our statistical diagnosis of students’ conceptions who learned electric and magnetic field using FCCI test instrument in the form of open-ended three-tier test is: understanding the concept about 15%, experience misconceptions about 25%, not understand about 41% and stay in parallel conception about 19%.

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