Constructing and Implementing a Four Tier Test about Static Electricity to Diagnose Pre-service Elementary School Teacher’ Misconceptions

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Abstract. We have already constructed and implemented the diagnostic test formed in the four tier test to diagnose pre-service elementary teachers’ misconceptions about static electricity. The method which is utilized in this study is 3D-1I (Define, Design, Develop and Implementation) conducted to the pre-service elementary school teachers. The number of respondents involved in the study is 78 students of PGSD FKIP Universitas Riau. The data was collected by administering diagnostic test items in the form of four tier test. The result indicates that there are several misconceptions related to static electricity concept, these include: 1) Electrostatic objects cannot attract neutral objects, 2) A neutral object is an object that does not contain an electrical charge, and 3) the magnitude of the tensile force between two charged objects depends on the size of the charge. Moreover, the research’s results establish that the diagnostic test is able to analyse number of misconceptions and classify level of understanding pre-service elementary school teachers that is scientific knowledge, misconception, lack knowledge, and error. In conclusion, the diagnostic test item in the form of four tier test has already been constructed and implemented to diagnose students’ conceptions on static electricity.

1. Introduction
Currently misconceptions have been one of considerable domain research in science education. Misconceptions between learners on problematic and abstract science concept can be met universal. Students are taught as if they had no prior ideas and experiences about science concept being studied previously. However, students’ minds are not empty; they are full of prior ideas and have
several daily life experiences related to scientific phenomena before coming to science course [1]. Students may have both scientifically acceptable ideas and some alternative conceptions in the same content area in science [2]. Students alternative ideas can be also referred to as alternative frame works [3] or misconceptions [4]. Misconceptions are resistant to change with scientific ones and students may reject accepting new ideas [5] and they are obstacles for students in learning and to make meaningful understanding of some concept in science. Students’ alternative conceptions in science can be originated from different sources; such as prior knowledge, daily life experiences, language, culture, teacher, textbooks and instruction [1].

Because misconceptions can resist the process of assimilating new knowledge, the misconceptions must be detectable as soon as possible. To detect the existence of misconception is necessary instrument that can reveal the state of conception owned by student. Because the state of conception is closely related to the student’s conception belief, the instrument to diagnose the state of conception held by the student is usually a compilation of the conception test and the level of conception belief. Some researchers have developed multiple-choice conception tests in various formats, such as two tier test format [6], three tier test format [7], and four tier test format [8]. Three tier tests were developed to perfect two tier tests by adding a tier of reasoning options. Four tier tests were developed to perfect the three tier test by adding a tier of choice for reasoning beliefs.

In this artifact, the scientists application on Four Tier Test instrument to analyze beginning of pre-service elementary school teachers to the conception of static electricity scholarly in Basic science concept. Four Tier Test instrument increase is reformed from the construction of instrument established by Vatansever [9] that completed up the instrument in format of the three-tier test kind, while the progress of every tier (level) has been settled and accumulated in first tier of some average assessments as in [9-12].Three Tier Test prepared into three levels (tiers), specifically: the first tier to the average inquiry in the form of multiple choice with five varieties, the second tier is assumed a blank for an description of the selected answer and third tier covers level of confidence (confidence rating) of the answers, specifically: very confident, not confident and do not know.

2. Method
The method used to construct conception test in four tier test format is 3D-I1 (Define, Design, Develop and Implementation). The define stage is done through field study and literature study to collect the kinds of misconceptions that occur in the concept of static electricity, the design stage is done to design the contents of each tier in the four tier test format, the develop stage is done to contract the conception test based on the design that has been made at the design stage. The number of conception test item developed is as much as three related problems of concept: 1) Electrostatic objects can not attract neutral objects, 2) A neutral object is an object that does not contain an electrical charge, and 3) the magnitude of the tensile force between the two charged objects depends on the size of the charge. Implementation stage was conducted to test the use of four tier tests developed in diagnosing the conception of prospective elementary school teachers at FKIP University of Riau. The number of responden was 78 students who contract the basic science concept course. To categorize the state of conception that belongs to the students was used the guidelines of classify the students in the categories of Scientific Conceptions (SC), Misconceptions (M), Lack of Knowledge (LK) and Error (E) [13,14].

3. Result and Discussion
The four tier diagnostic pieces have previously been arranged in the four-tier test in relationships of diagnosing the pre-service elementary teachers’ conceptions of the static electricity conceptions. The evolving research in this context connected with Three-D and one-I model (Define, Design, Develop and Implementation). For comprehensive analysis, we are going to pronounce follows.

3.1. Define
The Four Tier Diagnostic Test Items in static electricity concepts has been preliminary to be established in define part. Static electricity concept is a core concept for diagnosing equal of learners’
conceptions. Hence, the four-tier test arrangement was developed to progress this instrument. Why do the academics need to utilize the four-tier test items in creating this device? The academics need previously made the instrument through four tier test since in the preceding arrangement of three tier diagnostic test, we could not distinguish the only one self-confidence rating to the two (the first related to the several choices and the second tier associated to the reasons from the choose of the first tier). As stated in Kaltakci, Samsudin and samsudin [14-16], three-tier test has some faintness in order to analyse students’ conceptions specifically in the confidence rating subdivisions.

3.2. Design

In the next level of 3-D + 1I, we have previously built the four-tier diagnostic test items on Static electricity concepts. The scheme of these instruments created in the several choices and the explanations as shown in Figure 1. Arrangement is considered to be a four-tier test.

| Question: | Diagnose the state of student conception |
|-----------|-----------------------------------------|
| **Answer Choice (Tier I):** | A. Alternative choice of first answer  
B. Alternative choice of second answer  
C. Alternative choice third answer  
D. etc. |
| **The first Confidence Rating Scale (Tier II)** | A. Alternative option if “sure” over the selected answer  
B. Alternative option if “not sure” over the selected answer |
| **Reasons (Tier III):** | A. Alternative choice of first reason  
B. Alternative choice of second reason  
C. Alternative choice of third reason  
D. Other reasoning |
| **The Second Rating Scale (Tier IV)** | A. Alternative choice if convinced of the reasoning answer selected  
B. Alternative choice if unsure of the chosen reasoning |

**Figure 1.** Design of four-tier test

3.3. Develop

The four tier diagnostic test items stood involved four stages, namely: the major is multiple choices, the another is confidence rating connected to the first tier, third is cause for comprehensive the response in the first tier and the end (the fourth) is confidence rating associated to the third tier. The illustration of the conception test in the four tier format is publicized in the Figure 2.
**Question:** The image below shows objects that are positively charged “A” and a neutral “B”. If the two objects are closer then the possibility that will be happened is....

| A | B |
|---|---|

**Answer Choice (Tier I):**
A. Object B will not be withdrawn object A  
B. Object B is drawn by object A  
C. Object B is rejected object A

**The first Confidence Rating Scale (Tier II)**
A. Sure  
B. Not Sure

**Reasons (Tier III):**
The exact explanation according to the choice of answers from your choosing is ...  
A. Only electrically charged objects will be withdrawn by other electrically charged objects  
B. When a neutral object is approached by a charged object the charge will be polarized and the opposite electrical charge will be facing each other, so neutral objects will be attracted  
C. When a neutral object is approached by a charged object the charge will be polarized and a similar electrical charge will be facing each other, so the neutral object will be rejected  
D. ............................................................................................................

**The Second Rating Scale (Tier IV)**
A. Sure  
B. Not Sure

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**Figure 2.** Sample product of four-tier test about static electricity

3.4. **Implementation**

Attended calculation exploration data was the diagnostic effect of a profile of pre-service elementary school teachers’ conceptions that narrowing Basic Concept science course in the academic year 2016/2017. Quantitative data were articulated in percentages while qualitative data was attained significant data about the reasons for the answers on the first level. To classify the state of student conception based on four tier test results, the data analysis used as shown in table 1 is used.
Table 1. The category of pre-service elementary teachers’ conceptions through four tier diagnostic test [13-15]

| No | Category | Combination of answers | Option (Tier I) | The first Confidence Rating Scale (Tier II) | Reasons (Tier III) | The Second Rating Scale (Tier IV) |
|----|----------|------------------------|----------------|--------------------------------------------|------------------|----------------------------------|
|    | Scientific Knowledge (SK) | Correct | Sure | Correct | Sure |
|    | Lack of Knowledge (LK) | Correct | Sure | Correct | Not Sure |
|    | Correct | Sure | Incorrect | Not Sure |
|    | Correct | Not Sure | Correct | Sure |
|    | Correct | Not Sure | Correct | Not Sure |
|    | Incorrect | Sure | Correct | Not Sure |
|    | Incorrect | Sure | Incorrect | Not Sure |
|    | Incorrect | Not Sure | Correct | Not Sure |
|    | Incorrect | Not Sure | Incorrect | Not Sure |
|    | Misconception (M) | Correct | Sure | Incorrect | Sure |
|    | Correct | Not Sure | Incorrect | Sure |
|    | Incorrect | Sure | Incorrect | Sure |
|    | Incorrect | Not Sure | Incorrect | Sure |
|    | Error (E) | Incorrect | Sure | Correct | Sure |
|    | Incorrect | Not Sure | Correct | Sure |

Table 2 presents that the conception shapes connected to pre-service elementary school teachers remained in anxiety. This is outstanding to actual little percentage about 14.84% of students who scientific knowledge (SC). Besides, students who have misconceptions considerable developed than the students who scientific knowledge of static electricity, that is 42.03% comparative to 14.84%. The data intelligences that mindfulness of students when they learn static electricity concept in the elementary school level in the Basic Concept Science course to modification from the misconceptions to the scientific conceptions has previously conferred in Kaniawati et al. [17].

Table 2. Students’ conceptions profile on static electricity

| Number of concept | M (%) | LK (%) | SC (%) | E (%) |
|------------------|-------|--------|--------|-------|
| 1                | 48.62 | 21.65  | 13.16  | 16.57 |
| 2                | 39.47 | 29.54  | 18.36  | 12.63 |
| 3                | 38    | 49     | 13     | 0     |

In the table above shows that the number of students of elementary school teachers who misconception on each label of static electricity concept is quite a lot, even though they have followed the study of the concept of static electricity in lectures organized by lecturers. This incident allegedly has something to do with the lessons learned by lecturers cannot provide a sound understanding in the minds of the students. The inaccuracy of the learning method used is thought to be the strongest cause. The result of learning observation shows that the lecturer's learning using traditional method of information is not compatible with the character of the microscopic static electrical material and requires visualization media which can model the microscopic phenomena into macroscopic that can be observed by the eye. As noted above that one of the sources of the occurrence of misconceptions is the choice of inappropriate learning methods [1].
4. Conclusion
Has been successfully constructed the static electric conception test instrument in the form of multiple choice with four tier test format. The constructed test has shown a good function in identifying the state of conception in the minds of the students. This is demonstrated by the ability of instruments developed in differentiating students who have a scientific conception, experiencing misconceptions and lack of knowledge.

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