Identification of misconceptions on global warming material: impact and solutions at middle school

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Abstract. This study aims to identify the misconceptions of global warming material: impacts and solutions using the three-tier test diagnostic instrument. The Earth and Space Science material in the global warming chapter of the 2013 curriculum was given to the second semester of class XI so it was very new for high school students. The object of this study was 61 high school students of class XII who were scattered in two schools in Bandung, West Java randomly. The results of the analysis obtained the percentage of students who experienced more misconceptions compared to students who had scientific conception of 40.2%, while students with scientific conception were 36.6%, with the lack of knowledge 16.5% and error 6.7%. The percentage of students who experienced more misconceptions in the submission of solutions to global warming from the submersion of the impact of global warming was 45.74% while the submersion of the impact of global warming was 31.85%. These results indicate that students still experience misconceptions in Earth and Space Science material due to learning methods and the use of teaching aids that are still lacking.

1. Introduction

One of the main functions and objectives of physics subjects is as a means to master the knowledge, concepts and principles of physics and has the skills to develop knowledge, skills and attitudes of self-confidence so that they can be applied in daily life and as a means to continue education at a more advanced level height [1]. Physics subjects are subjects that develop students' systematic thinking so that they are not only not mastering knowledge in the form of concepts and facts. Knowledge of physics subjects is expected to be able to become knowledgeable about themselves and the environment and can further develop their knowledge in everyday life. In the 2013 curriculum framework the purpose of physics learning is to master concepts and principles and have the skills to develop knowledge and self-confidence as a provision to continue education at a higher level and develop science and technology [2]. This shows that the importance of organizing physics subjects at the education level at the high school / MA level. In the process of further physics subjects are important in harmonizing the knowledge held based on facts so that strong knowledge of the physics concept is formed.

Basic abilities possessed by students should be a construction to be able to develop their knowledge into a single entity so that in understanding physics as a whole [3]. Physics learning obtained at the elementary to high level is not impossible to give misconceptions to most students. Physics concepts
related to natural phenomena are mostly learning which emphasizes contextual and factual more. But in reality, most physics learning is still informative, more often gets information from teachers who are lectures, learning that raises mathematical equations and count questions so it is very difficult for students to understand the concepts of physics. Researchers misconceptions find various things that are the cause of misconceptions in students. Broadly speaking, the causes of misconceptions are: students, teachers, textbooks, contexts, and teaching methods. The causes that come from students can be preconceptions, abilities, stages of development, interests, and ways of thinking. The underlying cause of the teacher can be in the form of teacher inability (qualifications), lack of mastery of materials, learning models used, teacher attitudes toward students who are not good. While the causes of misconception are contextual, such as everyday culture and language [4].

In general, the level of misconception about the material of global warming of high school students is still very high, both influenced by several factors so that it can influence the knowledge of students' physics concepts. Student learning outcomes that still emphasize memorization and only provide information without interpreting the information obtained by the student. Contextual learning that emphasizes factual knowledge is very minimal affecting students in understanding the material of global warming. The learning process that only emphasizes the teacher (teacher center) can bring misunderstanding to students so that it can lead to misconceptions. Teachers play a role in connecting (linking), monitoring and directing the process of knowledge development, while students recognize (recognize), integrate (extend), expand (extend), evaluate (evaluate) and reconstruct the conception. In this case, learning can be seen as a conceptual change [4].

2. Methods

Misconception is a contradiction or incompatibility of concepts that someone understands with the concepts used by physicists [5], whereas according to Fowler [6] misconceptions are something that is inaccurate in concepts, the use of wrong concepts, incorrect classification of examples, chaos of concepts different, and the hierarchical relationship of incorrect concepts, wrong thoughts, ideas, or wrong opinions.

Misconceptions can be overcome by diagnostic tests. According to the Ministry of National Education [7] diagnostic tests as tests can be used to determine the strengths and weaknesses of students. Information on student misconception can be identified through several techniques including interviews, multiple choice tests, and two-tier Multiple-choice Tests [8]. two-tier Multiple-choice Test is a test instrument that is quite successful in diagnosing misconceptions and is easy to assess, but in line with the opinion of Hasan, Bagayoko and Kelly [8] two-tier Multiple-choice Tests cannot distinguish misconceptions from lack of knowledge (lack of knowledge) or lack of concept. Hasan, Bagayoko and Kelly [8] developed a three-tier test. This test instrument is the development of a two-tier test combined with the Certainty Response Index (CRI). Criteria for students who experience misconceptions and students who experience lack of knowledge or lack of concept as listed in Table 1

| Analysis | Category        | Answer type                                    |
|----------|-----------------|------------------------------------------------|
| Three Tier-Test | Scientific concept | Correct answer + correct reason + sure          |
| Lack of Knowledge |                          | Correct answer + correct reason + not sure      |
|           |                  | Wrong answer + correct reason + not sure        |
|           |                  | Correct answer + wrong reason + not sure        |
|           |                  | Wrong answer + wrong reason + not sure          |
| Error    | Misconception    | Correct answer + wrong reason + sure            |
|          |                  | Wrong answer + wrong reason + sure              |

The research design used in this study is a single instrumental case study, where case study research is carried out using a case to describe an issue or concern. The population of this study was the XII class
students who had implemented the 2013 curriculum in the 2016/2017 school year spread across the Bandung Municipality of West Java, while the sample was taken only 61 students from two private high school in Bandung. Time for data collection on 23-24 August 2018. The data collection tool used is as follows: 1) Questionnaire for students and teachers, to get a picture of students and teachers about learning in class and Earth and Space Science learning on global warming material after the change of curriculum. 2) Diagnostic tests in the form of three tier tests are 5 questions to measure students' misconceptions on global warming material: Impacts and Solutions. The measured misconception consists of 2 questions about the impact of global warming and 3 questions about the solution to global warming.

5.1 The increasing amount of greenhouse gases will make the earth's temperature will continue to increase. The correct statement about the greenhouse effect is....
   a. The greenhouse effect is a natural phenomenon
   b. The greenhouse effect is not a natural phenomenon
   c. The greenhouse effect has no effect on humans

5.2 Which is the reason for your answer to the previous question?
   a. The greenhouse effect does not occur naturally but is man-made
   b. The greenhouse effect just happens not to involve living things
   c. The greenhouse effect occurs naturally involving all substances in nature
   d. .......................................................... 

5.3 Are you sure of the answer you gave from the two questions above?
   1. Sure
   2. Not sure

Figure 1. Three tier of global warming test

3. Results and Discussion

3.1 Identification of Student Misconceptions
The results of the tabulation of the percentage of students who had misconceptions, scientific conception, lack of knowledge, and errors in submerging the effects of global warming, found that 26.41% of student’s misconception the concept of the impact of global warming on living things. On the concept of ozone depletion 37.28% of students have misconceptions. Whereas in the submission of the solution to global warming it was found that 35.06% of student’s misconception the concept of limiting waste disposal and limiting the use of pesticides. On the concept of using AC from the submersion of global warming solutions 50.32% of students’ misconceptions, and 51.84% of student’s misconceptions on the concept of using smoke filters and not throwing garbage into the river. Can be seen in table 2.
**Table 2.** Percentage of students who are misconception (MC), Scientific conception (SC), Lack of Knowledge (LK) and error (E) in the submersion of global warming

| No | Misconception of materials                                      | Percentage |         |         |         |
|----|-----------------------------------------------------------------|------------|--------|--------|--------|
|    |                                                                  | MC SC LK E |        |        |        |
| 1  | Impact of global warming on the living things                   | 26.41 62.18 6.33 5.09 |
| 2  | Depletion of the ozone layer                                   | 37.28 39.88 14.99 7.85 |
| 3  | Limitation of the waste disposal                               | 35.06 42.64 18.99 3.30 |
|    | Restricting of the use of pesticides                            |            |        |        |        |
| 4  | Use of AC                                                      | 50.32 27.11 19.53 3.03 |
| 5  | Use of smoke filter                                            | 51.84 11.15 22.84 14.18 |
|    | Do not throw garbage into the river                            |            |        |        |        |

In table 2 if expressed in graphical form it can be seen an illustration of the percentage of students who have misconceptions, scientific conceptions, lack of knowledge and errors from each submission of global warming. From the graph it can be seen the percentage of students who experience more misconceptions in the submission of solutions to global warming than the submersion of the effects of global warming and inversely proportional to the scientific conception of students. Where students whose scientific conception of submersion impacts of global warming are more than the submersion of solutions to global warming.

**Identification of misconception**

![Graph showing percentage of students who are misconception (MC), Scientific conception (SC), Lack of Knowledge (LK) and error (E) on each concept](attachment://figure2.png)

**Figure 2.** Percentage of students who are misconception (MC), Scientific conception (SC), Lack of Knowledge (LK) and error (E) on each concept

Overall the percentage of students who experience misconceptions is more than 40.2% of students with scientific conception, while 36.6% of students with scientific conception, with a lack of knowledge 16.5% and 6.7% error. This shows that there is still a lot of global warming material in the 2013 curriculum given to students who experience misconceptions.
3.2 Analysis of Student and Teacher Questionnaire

3.2.1. Student Questionnaire Analysis. From the students' answers to the questionnaire given to high school the following results were obtained: 1) Students are interested in Earth and Space Science material taught at school, 2) Learning material for Earth and Space Science material taught is not monotonous, 3) Students are not good at understanding Earth and Space Science material, 4) In learning Earth and Space Science material students expect more use of teaching aids, 5) Earth and Space Science material learning taught more uses video-based visualization, 6) Learning methods provided by the teacher to be more interesting, 7) Facilities that support the study of Earth and Space Science material at school are improved.

3.2.2. Teacher Questionnaire Analysis. From the teacher's answer to the questionnaire given to high school the following results were obtained: 1) Earth and Space Science material in schools is very interesting to teach, 2) The availability of other reliable learning resources to support Earth and Space Science learning, 3) The Earth and Space Science material taught must be completed with interesting and innovative methods with supporting teaching aids so that they can produce products in the form of props.

4. Conclusions
Based on the analysis and results of this study, it can be concluded as follows: 1) Based on data analysis, many students experience misconceptions in the submersion of global warming solutions rather than submersion of the effects of global warming, 2) Overall students experience misconceptions on IPBA material on global warming: impacts and solutions to global monitoring, 3) The IPBA material taught at school is very interesting for students and teachers but it needs learning innovation and teaching aids that support IPBA learning in schools.

5. References
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