The Effectiveness of learning materials based on multiple intelligence on the understanding of global warming

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Abstract. This study aims to examine the effectiveness of the use of teaching materials based on multiple intelligences on the understanding of high school students’ material on the theme of global warming. The research method used is static-group pretest-posttest design. Participants of the study were 60 high school students of XI class in one of the high schools in Bandung. Participants were divided into two classes of 30 students each for the experimental class and control class. The experimental class uses compound-based teaching materials while the experimental class does not use a compound intelligence-based teaching material. The instrument used is a test of understanding of the concept of global warming with multiple choices form amounted to 15 questions and 5 essay items. The test is given before and after it is applied to both classes. Data analysis using N-gain and effect size. The results obtained that the N-gain for both classes is in the medium category and the effectiveness of the use of teaching materials based on the results of effect-size test results obtained in the high category.

1. Introduction
Multiple intelligences is a dual ability to solve the problems that faced in life [1]. The concept of multiple intelligences is begun by Howard Gardner with his work in the book Frames of Mind in 1983 based on the results of research for several years about the human cognitive capacity (cognitive Human Capacities). Gardner [1] reject the assumption that human cognition is one unit and the individual only has a single intelligence. The research results show that there is no human activity that only uses one kind of intelligence, but the entire intelligence is verbal-linguistic intelligence, logical-mathematical, visual-spatial, kinesthetic, musical, intrapersonal, interpersonal and naturalist [1]. All of this intelligence work together as a unified whole and integrated. The composition of its integration, of course, vary depending on each person. Overall, the most prominent of all intelligence will control the other intelligence in solving problems. This concept has an essence that every person is unique; every student is different because it has a different combination of intelligence [1].

In the process of learning, teaching and education provided to students should focus on intelligence possessed by each student [2-4]. For example, if someone has the advantage in terms of music, the parents or teachers should develop such capabilities. Differences intelligence of each student not only shows the contents of the intelligence but also on the students’ learning style receives instruction [1, 5]. During most of the learning and teaching materials [6] only refers to verbal and logical-mathematical intelligence [7], whereas many other bits of intelligence that if the note will greatly assist the
development of students. More kinds of intelligence that are growing, then the student will be quickly adapted to the environment and faster in learning or mastering the material [2].

Teaching materials is important to improve the quality of learning. The teaching materials development can make students have autonomy and intact independence to do their learning activities [6]. Presentation of the Earth and Space Science materials in schools often rely on the available package books. Multiple intelligences developed the teaching materials, namely global warming theme for linguistic, explain the meaning of the heat and the specific heat capacity, registering the characteristics and examples of acid and alkaline solution, explain the influence of the greenhouse effect on global warming; logical-mathematical intelligence, investigating the influence of the concentration of CO₂ on global warming, determine the heat capacity, the amount of heat, and the specific heat of a substance; visual-spatial intelligence, find a relationship between the form of the appearance of the clouds with the temperature of the environment, identify the acid-base solution using litmus paper of universal indicator; kinesthetic intelligence, conducting experiments determining the heat and the specific heat capacity and the factors that influence it; musical intelligence, sang a song to memorize a list of examples of pollutant gases in the atmosphere; interpersonal, group discussion activities seek various sources of air pollution and to cooperate in identifying the environment; intrapersonal intelligence, introspection student activities such as registering the impact and behavior to prevent the acceleration of global warming; naturalist, activity observed natural phenomena such as the appearance of a cloud explain the relationship with the temperature of the environment, mitigating the effects of global warming. The preparation and development of teaching materials are not discussed in this article and described in other articles. This study describes the use of teaching materials on global warming theme oriented multiple intelligences in the learning process.

2. Methods
The study uses a quantitative research with the static-group pretest-posttest design [8]. Static-group pretest-posttest design was used to compare two classes preconceived, the experimental class using multiple intelligences based teaching materials and the control class does not use the multiple intelligence-based teaching materials in the learning process. Before administering the treatment, the students in the experimental class and control class is given a pre-test to measure students' mastery of concepts. In addition, students in the experimental class given the identification of multiple intelligences questionnaire to identify students’ intelligence dominant as the consideration of the grouping students in the classroom. Then the students in the experimental class were given treatment in the form of learning using teaching materials, while the control class was given treatment in the form of learning that does not use teaching materials. After that, the students in the second class are given a post-test to measure students' mastery of concepts after being given treatment.

The research has been conducted on eleventh-grade high school students in Bandung city. Participants aimed at high school students with the consideration of the case themes raised in this study is taught at the high school level. Participants in the study consisted of 60 students of class XI were divided into two classes: the experimental class of 30 students and 30 students of the control class.

The instruments that utilized, first, multiple intelligence questionnaires developed by Thomas Amstrong [9] to identify the dominant multiple intelligence of the students. The questionnaire consisted of 40 statements that include eight types of intelligence and given to students before the students get treatment. Second, test mastery of the concepts used in the form of 15 multiple choices questions and an essay question 5 related to the theme of global warming. The test was given to the students before and after students get treatment. To check its validity, the instrument matter assessed by experts’ opinion (judgment experts) to 2 lecturers and 1 school teachers and tested before they are given to students with the results of 71% of matter in accordance with the indicator and 67% matter in accordance with the cognitive domain with details of improvements include changes in the editorial matter, change the wording in the answer choices, changes in cognitive appropriate with the matter, and the conversion of matter. Values obtained about the reliability of the test results was 0.65 in the high category for the multiple-choice and essay 0.49 for in the category enough.
The identification of multiple intelligences questionnaire for each statement that appears is given a score of one (1). Multiple intelligences value measured for each type of intelligence. Values obtained by students’ multiple intelligences is the percentage of questionnaires conformity with the conditions of students. The highest value obtained students’ multiple intelligences is the multiple intelligences dominant. The Concept Mastery Test, for every answer multiple choice questions correctly received a score of one (1) and one received a score of zero (0). As for the matter of essays, each item has a maximum score of three sections corresponding correct answer. To determine the increase students’ mastery of concepts, using the gain normalized developed by Hake [10].

The learning effectiveness is measured by comparing it with the control class. Data processing techniques to assess the magnitude of the difference between the two groups of so-called effect size [8]. The calculation formula Effect size used in the study is the formula for calculating the delta Glass. The use of delta Glass in this study refers to the standard deviation in the experimental class and control class is different. If the standard deviation of the two groups is different, the homogeneity of variance assumption is violated and the standard deviation is not appropriate unification. In this case, we can enter the standard deviation of the control group into our equation and calculate delta Glass. The logic is that the standard deviation is not affected control class effect treatment to reflect the population standard deviation [3, 4]. Glass delta formula is written as follows.

\[ \Delta = \frac{\bar{X}_2 - \bar{X}_1}{SD_1} \]  

(1)

Description:
\( \Delta \) = Effect Size  
\( \bar{X}_1 \) = the average of control class  
\( \bar{X}_2 \) = Average grade experiment  
\( SD_1 \) = standard deviation control class

The interpretation \( \Delta \) value shown in Table 1 as follows.

| Value of \( \Delta \) | Criteria |
|----------------------|----------|
| \( \Delta \geq 0.7 \) | high     |
| \( 0.7 > \Delta \geq 0.3 \) | intermediate |
| \( \Delta < 0.3 \) | low      |

3. Result and Discussion
The intelligence is related to the capacity/ability to solve problems and create products and works in a rich context and circumstances naturalistic [1]. When faced with a problem, the students solve them by their ability. The student’s ability in solving the problem depends on the type of the dominant intelligence they had. The dominant intelligence of the students can be seen from the results of the questionnaire identification of multiple intelligences. The highest score obtained by students from eight types of intelligence is the dominant students’ intelligence. The results of the identification of multiple intelligence showed most students have more than one dominant intelligence and some students only have one intelligence dominant in detail as shown in Table 3. The number of students and the percentage of multiple intelligence showed a majority of students have a dominant intelligence on intrapersonal intelligence type with a percentage of 40% obtained from 12 students. These results consistent with previous studies [12 - 14].
Table 2. Number of Students’ Intelligence

| Number of Dominant Intelligence | Number of Students |
|--------------------------------|--------------------|
| 1                              | 11                 |
| 2                              | 10                 |
| 3                              | 4                  |
| 4                              | 3                  |
| 5                              | 2                  |

The intrapersonal intelligence is the ability to understand oneself. Middle school students have reached puberty, which began with the development of physical, psychological, social, and intellectual, in other words, there has been a change in these aspects [14]. While the dominant type of intelligence is the linguistic lowest student with a percentage of 10% were obtained from three students. Gardner [1, 15] states that only two types of intelligence (linguistic and logical-mathematical) that have been assessed and tested in a modern school. On another occasion, Gardner [1] states that the concept of intelligence relating to linguistic and logical-mathematical ability was considered too narrow and fail to capture a wide range of intellectual functioning human being. These results indicate that today’s modern learning (focus on linguistics) less accommodate the students’ multiple intelligence because of the dominant intelligence of diverse students. The number of students and the percentage of students in the class dominant intelligence in detail is shown in Table 3 below.

Table 3. Percentage of Students’ Intelligence Dominant Type

| Type Intelligence        | Number of Students | Percentage (%) |
|--------------------------|--------------------|----------------|
| Linguistics              | 3                  | 10             |
| Logical-Mathematical     | 11                 | 37             |
| Visual-Spatial           | 9                  | 30             |
| Kinesthetic              | 8                  | 27             |
| Musicals                 | 8                  | 27             |
| Interpersonal            | 9                  | 30             |
| Intrapersonal            | 12                 | 40             |
| Naturalis                | 5                  | 17             |

The results of the identification of students’ intelligence dominant used as a reference for grouping students in classes so that in each group of 4-5 students with a tendency dominant intelligence different. The results of the identification of the dominant intelligence of the students related to learning and solving problems experienced by students.

Mastery of the concept in question refers to the Taxonomy C1 to C4, namely remembering, understanding, applying and analyzing. Increased mastery of concepts is measured by the average gain is normalized from the results of pretest and posttest the experimental class shown in Figure 1 below.
Figure 1 shows an increase in students' mastery of concepts in the experimental class and control class after being given treatment with the value of N-gain each category were 0.49 and 0.32 being intermediate categorized. This suggests that learning is used in both classes can improve students' mastery of concepts with the same relative category is the category of being. Value pretest and posttest reviewed based on cognitive students in the experimental class and the control class as shown in Table 4 and Table 5.

### Table 4. N-Gain Multiple Choice on Cognitive Domain

| Cognitive Domain | N (Number of questions) | Average Experimental Class | <g> | Average Control Class | <g> |
|------------------|-------------------------|-----------------------------|-----|-----------------------|-----|
|                  |                         | Pretest | Posttest | Pretest | Posttest |
| C2               | 7                       | 2.7     | 5.7      | 0.69     | 1.7     | 4.07     | 0.45 |
| C3               | 2                       | 0.6     | 1.4      | 0.57     | 0.43    | 0.9      | 0.29 |
| C4               | 6                       | 2.5     | 3.7      | 0.36     | 2.5     | 2.7      | 0.06 |

### Table 5. Score of Essay on Every Cognitive Domain

| Cognitive Domain | N (Number of questions) | Average Value of Experimental Class | <g> | Average Value of Control Class | <g> |
|------------------|-------------------------|------------------------------------|-----|--------------------------------|-----|
|                  |                         | Pretest | Posttest | Pretest | Posttest |
| C1               | 1                       | 0.7     | 0.3      | 1       | 0.57    | 2.63     | 0.85 |
| C2               | 4                       | 1.17    | 4.93     | 0.35    | 0.77    | 3.37     | 0.23 |

The data shows that the cognitive C1 and C2 no difference N-gain significant between the experimental class and control class. However, at C3 and C4 cognitive differences N-gain significant in both classes. This suggests that the experimental class learning more can improve students' ability to think on a higher cognitive learning than the control class. Increasing students' mastery of concepts in the experimental class can be influenced also by the type of the dominant intelligence of the students because it is closely related to student learning and learning provided [1, 5, 16], are shown in Table 8. Overall, the increased of students’ concept mastery was categorized in each type of multiple intelligences, value N-gain highest obtained on the type of linguistic intelligence. While the value of n-gain lowest obtained on the type of naturalist intelligence.
To determine how much influence or effectiveness of learning by using multiple intelligence based teaching material in the experimental class was measured the effect size by comparing the value of posttest in both classes. The effect size value obtained by 1.46 including in the high category [8], it shows that learning to apply materials that accommodate multiple intelligences has a high impact on student achievement. This is consistent with research Ozdemir et al [17].

4. Conclusion
The result of identification multiple intelligence shows the diversity of types of students’ multiple intelligences. There are some students which have one, two and five intelligence and merge into a single entity forming ability of individuals is quite high. Most students demonstrate mastery of different concepts. Increasing students’ mastery of the concept of using multiple intelligence based teaching materials medium category. The amount of influence or effectiveness of the use of multiple intelligences based teaching materials included in the high category.

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Table 6. Score Mastery of Concepts on each Dominant Intelligence

| Intelligence Type  | Number of Students | Average of Posttest | Average of Pretest | <g> |
|--------------------|--------------------|---------------------|--------------------|-----|
| Linguistics        | 3                  | 28.9                | 66.7               | 0.53|
| Logical-Mathematical| 11                 | 24.2                | 63.3               | 0.52|
| Visual-Spatial     | 9                  | 24.1                | 61.8               | 0.49|
| Kinesthetic        | 8                  | 26.2                | 63.3               | 0.50|
| Musical            | 8                  | 25.8                | 64.2               | 0.52|
| Interpersonal      | 9                  | 27.0                | 62.9               | 0.49|
| Intrapersonal      | 12                 | 23.8                | 62.2               | 0.50|
| Naturalis          | 5                  | 26                  | 59.3               | 0.45|
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