Eco dome a potential experiment tool for greenhouse effect

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Abstract. This study aims to provide information about the characteristics of eco dome as tool for greenhouse effect experiments. This research uses experimental method. This research was held in 2019 at FMIPA Universitas Pendidikan Indonesia. Experiment used eco dome include: the effect of presence of plants inside of eco dome towards changing temperature and the effect of administration of CO₂ in eco dome that presence of plants towards changing temperature. Data collection was done by measuring the temperature and intensity of light. Data analysis uses statistical tests. The result of this experiment was temperature in eco dome which has no plants inside is higher rather than temperature in eco dome which present plants inside. Another result is the added of CO₂ in eco dome which contain plant has higher temperature rather than eco dome which has no CO₂ added. Experiments shows the eco dome has characteristics in showing significant results and can be developed various potency.

1. Introduction
Learning with science on experiment work is not just about study about the content but also learn the experience of study to built skill and gain the knowledge. Science learning activity build the way to critical thinking, creativity, collaboration, skills to communicate and innovation [1]. Therefore science learning is presented through method, strategy and media to build skills that required in 21st century life. Learning process by experiment is the activity to examine and applied the theory. Experiment in science learning is effective method to reach the learning objectives [2]. Experiment is critical role in learning activities especially in science because an experiment can prove theory. [3]. An experiment is directed to expand potency as learning outcome [4].

Abstract concept is only can be imagined without proof, thus the students have not gained the knowledge form chapters they had learned. One of the concept that consists abstract concept that difficult for students to understand is greenhouse effect. The greenhouse chapter is science chapter that important to talk about [5] furthermore greenhouse effect affecting global warming [6-7]. Some research have shown that there are many students do not well understand and having misconception on greenhouse effect concept [5] [8].

The Planet Earth has an atmosphere, which keeps us warm. This simple fact is now replaced by the idea that we live in a greenhouse, and the so called greenhouse gases keep us warm. This is explained the following way: The Earth receives visible light from the Sun, which heats the surface, which then emits infrared radiation, which is absorbed and re-radiated by the greenhouse gases in the atmosphere. The more CO₂ we emit the more radiation is reemitted from the atmosphere and we will experience a
catastrophic warming of our planet [9]. Plants contribute a lot in the capture of carbon dioxide load from the atmosphere in the process of photosynthesis. Carbon is the source of energy for plants. During photosynthesis, plants take in CO\(_2\) and give off the oxygen (O\(_2\)) to the atmosphere. The oxygen released is available for respiration [10].

The purpose tool is to help increase the learning process quality to reach learning objectives [11]. Eco dome is one of learning tool. Eco dome is earth miniature or ecosystem miniature that shows how life in earth. The use of eco dome can produce some experiments.

2. Methods
Research method was experimental method. This research was held in 2019 at FPMIPA of Universitas Pendidikan Indonesia, Bandung. Research procedures divided into 5 steps, those were the first step was literature study to theories that related to experiment. The second step was designing tool. The purpose of designing tool is determine the shape and the size of tool. The third step was constructing the tool The forth is examine tool by experiments, include: 1) the effect of presence of plants in eco dome and 2) the effect of administration of CO\(_2\) in eco dome that consist of plants towards temperature changing.

The procedural of experiment 1: was taking the soil used small shovel, stirred until the soil homogeny, after the soil is stirred, put the soil into two eco domes. Plants that has prepared has 5-15 cm in length and still fresh, then take them and plant it in one of eco domes, another eco dome is not filled by soil. After that three thermometers were calibrated until homogeneous. Put 1 thermometer in each of two eco domes and 1 thermometer and lux meter in the outside eco dome. Then close and put them under sunlight or lamp. Two eco dome should have received the heat energy at the same level of quality.

The procedural of experiment 2: was taking the soil used small shovel then placed it into container then stir it to make soil homogeneous then put it in to eco dome. Plants that used are different one and another which consist of 12-18 of plants with 10-15 cm high that measured by rules. After that the plants put inside the eco dome. Both eco dome were planted with the same kind of plants with same size. The next step is creating CO\(_2\) solution. Firstly pour hot water into both bottles each 600 ml. Then put the sugars in with 5 spoon amount through roll paper to avoid them to fall out. Then put in ½ sodium bicarbonate in a bottle , the put ½ tea spoon of yeast in a bottle as well, then close the cap to make them homogeneous. Put one of pipe inside the cap bottle that has perforated, then put in another pipe inside eco dome through plasticine. To make the air well flow just close the other hole with plasticine, then put 1 thermometer of each eco dome inside and 1 thermometer and lux meter in the outside eco dome, make sure the thermometer has calibrated, then put both eco dome under direct sunlight or lamp. Pay attention to both of eco dome that receive heat energy.

The fifth step was taking the data to analyze the changing temperature inside or outside the eco dome and light intensity. Retrieval of experiment by doing 3 repetitions. Data analysis has used statistical test.

3. Result and Discussion

3.1 Eco dome
The Eco System Eco Dome Planet Management was produced by “Wild Science” in 2011 in Taipe, Taiwan. Eco dome was firstly designed by biologist, biophysic expert and science education expert that experiences in making and exploring climate and biology. Eco dome is a thing that made of transparent glass that used as ecosystem miniature to place plants. Thus eco dome is used for biology mini laboratory.
Figure 1. Design of eco dome

Figure 1 shows a eco dome: 1) Lid cup is used as experiment direction as roof cover. The cover is higher than the body tool. This thing eases the process of water flows; 2) roof or lid is used as atmosphere because it has a cover that has the same function as earth’s atmosphere; 3) mountain lake or highland lake, is used to figuring out mountains and lakes on highland; 4) highland or upper terrace is used is figuring out as earth’s highland; 5) lowland or lower terrace, is figuring out the earth’s lowland; 6) Water channel is water tube. The function is used for a media to flow the water from highland to lowland. Each extent has two tubes; 7) the sea or lowland lake, is figuring out the sea or earth life in lowland; 8) plug, is founded in two parts of tool which created the hole with diameter 2 cm as place to plug in tool as put the CO$_2$ into tubes; 9) lower platform, as lowland; 10) Base or called as basic earth.

When eco dome is put under direct sunlight, sunlight penetrates the glass. Some of the light absorb by anythings that put in eco dome. In eco dome that consists of plants sunlight will used in photosynthesis process and the remain light will absorbed by soil. Some energy is absorbed by eco dome surface and the remain energy will reflect. The reflection of light from things that put in eco dome is restrained by cover glass then the air in eco dome will get warmer. The function of glass is analog as greenhouse effect gasses on atmosphere. Greenhouse effect gasses absorb and trap the heat [12].

3.2 Experiment uses eco dome for understanding the characteristic of eco dome

3.2.1 The effect of presence of plants inside of eco dome towards changing temperature (experiment 1). The purpose of this step is creating experiment data about the presence of plants in eco dome towards temperature changing. The first eco dome is filled by plants while another is not.
Figure 2. The experiment of presence of plants in eco dome towards changing temperature.

Figure 2 shows eco dome that filled by plants. This experiment is to observe the temperature changing inside and outside the eco dome and to measure the intensity of light each 5 minutes along 50 minutes.

Figure 3. The relation between time over temperature inside and outside eco dome

Figure 3 shows there is difference in changing temperature inside and outside of eco dome. The temperature in eco dome that not fill by plants (eco dome it is resulting B) is higher than eco dome that fills with plants (eco dome it is resulting A), longer time to do the experiment the higher temperature that produced. The result data of experiment about light intensity towards temperature changing is shown in figure 4.
Figure 4. The effect of light intensity towards changing temperature

Figure 4 shows that temperature is directly proportional over sunlight intensity. The higher intensity of the light then the higher temperature will produce. The cause of decreasing temperature in eco dome that not fill by plants is because the plants that placed inside the eco dome does photosynthesis. The plants absorb gasses like CO$_2$ that founded inside eco dome. The less of CO$_2$ is founded in eco dome then the low of temperature will produce. Another eco dome that not filled with plants will not do the photosynthesis. There is no amount of CO$_2$ is getting decrease. CO$_2$ is founded in the soil while eco dome maintain the heat. This experiment shows eco dome has characteristics in produced significant data.

3.2.2 The effect of administration of CO$_2$ in eco dome that unpresence of plants towards changing temperature (experiment 2). This experiment is aim to create the data about the effect of CO$_2$ administration inside the eco dome that filled with plants towards changing temperature.

Figure 5. The effect of administration of CO$_2$ in eco dome that fill with plants towards temperature changing

Figure 5 shows 2 eco dome that filled with plants that added by CO$_2$ solution. This experiment is aimed to observe the temperature on both eco dome and measuring the light intensity. The process can be seen in each 5 minutes along 50 minutes.
Figure 6. The relation between time over temperature inside and outside the eco dome

Figure 6 shows there is the difference between temperature inside and outside the eco dome. Temperature inside the eco dome is higher than the outside. Temperature in eco dome that is administered with CO\textsubscript{2} is higher than another eco dome. The longer this experiment takes time the higher temperature will produce. The graph of light intensity towards changing temperature is shown in figure 7.

Figure 7. The effect of light intensity towards temperature

Figure 7 show that temperature is directly proportional towards sunlight intensity. The longer light intensity then the higher temperature will produce. This experiment shows eco dome has characteristics in produced significant data.

The cause of higher temperature in eco dome that filled with plants and administrated by CO\textsubscript{2} is because the higher amount of CO\textsubscript{2} turn the absorption of sunlight that reflected from eco dome surface to higher. The higher amount of CO\textsubscript{2} will make the absorption of CO\textsubscript{2} is higher. Meanwhile in eco dome that filled with plants without administration of CO\textsubscript{2} will make the temperature is lower because plants absorb CO\textsubscript{2} that founded inside eco dome.

Based on the experiment data that has shown, it proofs that plants have function to do photosynthesis that will absorb CO\textsubscript{2}. This experiment used eco dome to illustrate how pollution affects the earth. The existence of quantitative facts various competencies can be developed, including; (1) the ability to analyze the relationship between variables, such as the relationship of intensity towards temperature and time towards temperature; (2) the ability to predict conditions that will occur due to
an increase in factors that affect changes in temperature (3) the ability to change and interpret graphs, and others. This quantitative skill is very important, considering the future life of development in information in various fields related to numbers [13 14].

4. Conclusion

Utilizing the eco dome will create a new innovation experiment namely "the effect of the presence of plants on temperature changes and the effect of CO₂ administration in eco domes filled with plants on temperature changes”. The results of this experiment are that the temperature inside the eco dome filled with plants is lower than other eco dome plants that have not been filled. Meanwhile the administration of CO₂ in eco dome filled with plants is higher than the eco dome which is not managed by CO₂. Experiments use eco dome to create quantitative data. Eco dome has characteristics in showing significant results and can be developed various potency.

5. References

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