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MAKING LEARNING MEDIA FOR GREENBOX EFFECT SIMULATOR TO IMPROVE UNDERSTANDING OF THE CONCEPT OF THE GREENHOUSE EFFECT

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Abstract. The earth is experiencing global warming due to an increase in air temperature (greenhouse effect). This is due to the large number of greenhouse gases produced by human activities. In addition, it is also due to the reduced number of plants that absorb greenhouse gases, especially carbon dioxide. This condition causes the study of the greenhouse effect to become an object studied by students at school. Understanding the greenhouse effect is somewhat difficult if only understood in theory. Increasing understanding can be done by making practicum learning media. This study aims to create learning media for the Greenbox Effect Simulator to help understand the concept of the greenhouse effect. The research was conducted using control variables and independent variables (use of plants and without plants). The plants used are Caisim, Sri Gading and Anggrek. The presence of carbon dioxide (CO_2) greenhouse gases can be detected by three things, namely changes in the color of the CO_2 indicator, changes in temperature, and visibility of the box. The color of the CO_2 indicator shows green and green yellow for Box B (with plants) which means the concentration of CO_2 in normal conditions. Whereas Box C (without plants) gives a yellow color, which means that the concentration of CO_2 is at high conditions. The presence of carbon dioxide gas from combustion will increase the temperature by 1.4 - 1.9 ^oC in Box C (without plants) and 0.7 - 1.5 ^oC in Box B (use of plants). The visibility of Box B shows a higher brightness level than Box C. The best plants that can absorb CO_2 concentrations are orchids. The ability of orchids to absorb CO_2 is assisted by their roots which also function to carry out photosynthesis. The existence of plants functions to absorb CO_2 quite well when viewed from changes in temperature, color indicators and visibility.

Keywords: learning media; greenbox effect simulator; greenhouse effect

I. INTRODUCTION

The world's air temperature has increased by 0.6 degrees Celsius (1 degree Fahrenheit) since 1861 according to a report from the Intergovermental Panel on Climate Change (IPCC). Some scientists predict that the increase in the world's average temperature ranges from 1.1 ^oC to 6.4 ^oC in the range 1990 to 2100. The increase in air temperature is caused by various factors, one of which is the activities carried out by humans.

Human activities that can increase world air temperature include burning carbon emissions used in industry, using inefficient fuels in motorized vehicles, reducing vegetation such as logging and other activities (Pratama **[1]**). As the human population increases, the daily needs will also increase. In order to meet these needs, it will also have an impact on increasing the burning of carbon emissions.

The result of combustion is in the form of carbon dioxide (CO_2) which will evaporate into the atmosphere. Carbon dioxide (CO_2) in the atmosphere will continue to increase along with the increasing activity of burning carbon emissions on earth. The increase in carbon dioxide (CO_2) gas in the atmosphere will have an impact on trapping heat radiation from sunlight that enters the earth's atmosphere **[2]**. The trapped heat radiation reflection cannot leave the atmosphere so that it will cause an increase in the earth's temperature. This phenomenon is called the greenhouse effect.

The increasing concentration of carbon dioxide gas in the atmosphere can trigger widespread climate change on earth. Climate change is generally known as Global Warming or global warming. Global warming that occurs can have a wide impact on all living things on earth. Some of the effects of global warming include weather disturbances, extreme natural disasters such as hurricanes, floods, drought, and many others. Extreme conditions with increasing water temperature, low dissolved oxygen concentration and water pH can cause fish mortality. An environment with non-optimal conditions can reduce the metabolic rate, growth and spawning ability of fish (Syahailatua **[3]**). Global warming can also trigger the melting of ice at the poles so that it will increase sea level rise around the world. This has the effect of decreasing land area and can increase the spread of diseases carried by mosquitoes.

The education sector is one of the focuses in providing knowledge about global warming. Global warming material at high school level and its equivalents that is delivered includes basic knowledge about the causes, impacts and solutions to be able to deal with the effects of global warming. A good understanding of students about global warming is needed so that solutions for handling and

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prevention can be started in everyday life. Students' understanding can also be a way to find alternative innovative solutions in the future. However, at this time there were still obstacles by the teachers to prove to students that the concept of the theory of the greenhouse effect or Global warming actually occurred in nature.

It is necessary to have learning media in the form of teaching aids / practicum that can show the occurrence of the greenhouse effect or Global warming on a laboratory scale that can be done in schools. This is in accordance with the results of research conducted by Hadi & Ainy **[4]** which shows that 68% of students believe that direct practice methods (practicum) can increase understanding of environmental conservation and its application in everyday life. Increased understanding obtained from practicum activities has a positive effect on students' daily conservation activities (Hadi & Ainy [4]).

There are several studies related to learning media regarding the greenhouse effect or Global warming. Learning media made include interactive games (Wuryandari & Akmaliyah **[5]**), student worksheets (Harnani & Suyatna **[6]**), SETS insights (Science, Environment, Technology, Society) (Latifah **[7]**), poster media (Maiyena **[8]**), learning cycle learning model (Mariya & Suyatna **[9]**), problem based learning method (Santoso **[10]**) and pocket book development (Yuliani **[11]**). There are also computer-based media in the form of simulations and games using Adobe Flash (Tham **[12]**), multimedia development uses the ADDIE approach (Analysis, Design, Development, Implementation, Evaluation) (Sukenda **[13]**), infographic media (Tobing & Admoko **[14]**), the use of Instagram social media (Nugroho & Ruwanto **[15]**) and the development of an interactive multimedia software module (Suwindra **[16]**).

The existing learning media are still deemed ineffective in providing students' understanding of the phenomenon of the greenhouse effect or global warming. Therefore, research on the making of learning media for greenbox effect simulators to improve understanding of the concept of the greenhouse effect is necessary. According to KBBI, a simulator is a tool that can simulate an actual situation. The purpose of this study is to determine the components and stages of creating a laboratory-scale greenbox effect simulator that is in accordance with the concept of the greenhouse effect. The resulting greenbox effect simulator can explain to students the changes in temperature due to combustion activity, the effect of plants on the rate of temperature drop and air visibility.

II. RESEARCH METHODS

The research was conducted during July - September 2020. The research location was conducted in the IPA laboratory of STKIP Arrahmaniyah Depok. The environmental conditions at the time of collecting research data were at room temperature and were not affected by air conditioning (AC). Making a greenbox effect simulator is done by making three research variables, namely control variables, independent variables and dependent variables. Control variables were made by arranging jars equipped with a digital thermometer, colored paper and carbon dioxide indicators. The independent variable was made by giving the treatment by burning tissue paper in a jar where there were plants and other jars where there were no plants. The dependent variables of the study were temperature changes, color changes on the indicator carbon dioxide and the visibility (brightness) of colored paper. The data collection instrument is in the form of a worksheet which contains information about changes in temperature, changes in the color of the carbon dioxide indicator and the visibility (brightness) of colored paper. The data obtained will then be analyzed through qualitative and quantitative descriptive analysis approaches. The qualitative analysis approach is carried out by making tabulations, graphs and photo documentation. The control variable (Box A) was made by preparing a 25 liter glass jar. Next step Post it labels are affixed in the order from the lightest color to the darkest color (pink, orange, green, yellow, cream). Then, the digital thermometer is installed using tape with the numbers facing the front of the jar. The CO_2 indicator glass is installed previously filled with 15 drops of CO_2 indicator liquid. Beaker Glass is put in a jar and filled with a sheet of tissue paper. The lid of the jar and Box A are ready to be treated

The making of the independent variables (with plants/ Box B) was carried out like the treatment of the control variables. Differences in treatment with plants. There are 3 types of plants used, namely Caisim, Sri Gading and Anggrek. The plants were put in a glass jar just before the experiment began. The lid of the jar and Box B are ready to be treated. The making of the independent variables (without plants/Box C) was carried out as in the control variable. The difference lies only in the experimental treatment.

The experimental treatment was carried out by placing Box A (control), Box B (with plants) and Box C (without plants) in a parallel position side by side to facilitate observation. Before starting, make sure that the temperature on the digital thermometer is the same number. The next step, the matches and the timer are in a stand-by position. The tissue burning treatment is carried out simultaneously on Box B and Box C, then the jar is immediately closed and the timer runs. The recording of the temperature was carried out for 30 minutes every one minute.

III. RESULTS AND DISCUSSION

The Greenbox effect simulator can perform simulations well in providing an overview of the greenhouse effect on a laboratory scale. The data obtained through the Greenbox effect simulator are temperature changes, color changes on the carbon dioxide indicator and the visibility (brightness) of colored paper as a result of the burning of tissue paper as a carbon source. Changes in temperature in the Greenbox effect simulator experiment can be seen in Table 1.

Table 1.Temperature changes in the Greenbox Effect Simulator experiment (in ^{o}C units)

Caisim				Sri Gading				Anggrek			
waktu (menit)	Box A	Box B	Box C	Waktu (menit)	Box A	Box B	Box C	Waktu (menit)	Box A	Box B	Box C
0	33,6	33,6	33,6	0	31,2	31,2	31,2	0	28,2	28,2	28,2
1	33,5	34,1	34	1	30,9	31,3	32	1	28,2	28,2	29,2
2	33,5	34,3	34,8	2	30,9	31,6	32,2	2	28,2	28,6	29,7
3	33,5	34,8	35	3	30,9	31,7	32,5	3	28,1	28,7	29,9
4	33,5	34,9	35,2	4	30,8	31,8	32,5	4	28,1	28,8	30,1
5	33,4	35,1	35,2	5	30,8	31,9	32,6	5	28,1	28,9	30,1
6	33,3	35,1	35,2	6	30,8	31,9	32,6	6	28	28,9	30,1
7	33,3	35,1	35,2	7	30,8	31,9	32,6	7	28	28,9	30,1
8	33,3	35	35,2	8	30,9	32	32,6	8	27,9	28,9	30,1
9	33,3	34,9	35,1	9	30,9	32	32,6	9	27,9	28,9	30,1
10	33,2	34,9	35,1	10	30,9	32	32,6	10	27,9	28,9	30,1
11	33,2	34,9	35	11	30,9	32	32,5	11	27,9	28,9	30
12	33,2	34,8	34,9	12	30,9	32	32,4	12	27,9	28,9	29,9
13	33,2	34,7	34,8	13	30,9	32	32,4	13	27,9	28,9	29,9
14	33,2	34,6	34,7	14	31	32	32,4	14	27,9	28,9	29,8
15	33,2	34,5	34,6	15	31	32	32,4	15	27,9	28,9	29,7
16	33,2	34,4	34,6	16	31,1	32	32,3	16	27,9	28,9	29,6
17	33,2	34,3	34,5	17	31,1	32	32,3	17	27,9	28,9	29,6
18	33,1	34,2	34,3	18	31,1	31,9	32,2	18	27,9	28,8	29,5
19	33,1	34,2	34,3	19	31,1	31,9	32,2	19	27,9	28,8	29,4
20	33,1	34,1	34,2	20	31,1	31,9	32,2	20	27,8	28,7	29,3
21	33,1	34,1	34,2	21	31,1	31,9	32,1	21	27,8	28,7	29,3
22	33	34	34,1	22	31,1	31,9	32,1	22	27,8	28,7	29,2
23	33	33,9	34,1	23	31,1	31,9	32,1	23	27,8	28,6	29,2
24	33	33,9	34	24	31,1	31,9	32,1	24	27,8	28,6	29,2
25	33	33,9	34	25	31,1	31,8	32	25	27,8	28,6	29,2
26	33	33,8	33,9	26	31,1	31,8	32	26	27,8	28,6	29,1
27	32,9	33,8	33,9	27	31,1	31,8	31,9	27	27,8	28,6	29,1
28	32,9	33,8	33,9	28	31,1	31,7	31,9	28	27,8	28,6	29
29	32,9	33,8	33,8	29	31,1	31,7	31,9	29	27,8	28,5	29
30	32,9	33,7	33,8	30	31,1	31,6	31,9	30	27,8	28,5	28,9

Information:
Box A = control treatment
Box B = greenhouse gas (CO2) exposure treatment with the addition of plants
Box C = greenhouse gas (CO2) exposure treatment without the addition of plants

The phenomenon of the greenhouse effect can be observed in this study through the temperature factor. Greenhouse gases, for example carbon dioxide have heat trapping properties, so they can raise the ambient temperature. Temperature Box C, namely the treatment without plants showed the highest temperature increase compared to the control (Box A) and treatment with plants (Box B). The first experiment using the Caisim plant, the temperature of Box C reached its maximum temperature of 35.2 ^{o}C from the initial temperature of 33.6 ^{o}C. Meanwhile, Box B experiences its maximum temperature at 35.1 ^{o}C. The temperature increase in the second experiment using Sri Gading plants showed that Box C (treatment without plants) reached a maximum temperature of 32.6 ^{o}C, while Box B (treatment with plants) reached a maximum temperature of 32 ^{o}C. The increase in Box C was 1.4 ^{o}C from the initial temperature of 31.2 ^{o}C. Meanwhile, Box B increased by 0.8 ^{o}C from the initial temperature. The presence or absence of plants gives a difference in temperature changes of 0.6 ^{o}C (Table 1). The third experiment using orchids showed very high temperature changes in the treatment without plants

(Box C) reaching a maximum temperature of 30.1 ^{o}C. This shows an increase of 1.9 ^{o}C from the initial temperature of 28.2 ^{o}C (Table 1). The treatment of giving orchids (Box B) increased the temperature from 28.2 degrees to 28.9 (up 0.7 degrees). Exposure to greenhouse gases accompanied by plants can withstand a temperature rise of 1.2 degrees. The temperature increase in the treatment of greenhouse gas exposure in the absence of plants shows a very drastic increase, which is almost two times the treatment of greenhouse gas exposure in the presence of plants. This shows that the existence of plants can function to stabilize environmental temperatures through the process of photosynthesis.

The use of plant species can actually affect temperature stability in the experimental box. Based on Figure 1, it can be seen that the orchid plants have the farthest distance compared to Caisim and Sri Gading plants between the difference from the maximum temperature line reached and the maximum temperature in the Box where there are no plants. This shows the ability of orchids to absorb CO_2 better than other plants.

Research by Aschan & Pfanz **[17]** states that in higher plants almost all vegetative structures of plants can carry out photosynthesis. Plant roots can carry out effective internal recycling of CO_2 by using CO_2 released from respiration. Goh et al., **[18]** and Aschan & Pfanz **[17]** stated that orchid roots have chlorophyll so that they are able to carry out photosynthesis. This is what causes orchids to absorb CO_2 better than Caisim and Sri Gading plants.

The combustion process produces carbon dioxide gas. CO_2 gas in the Greenbox Effect Simulator experiment, which comes from the combustion of tissue paper, can be determined using the CO_2 indicator. The initial color of the CO_2 indicator is blue, which means that the CO_2 concentration is low. Increasing the concentration of CO_2 in a row will make the color change to green, green yellow and yellow. The CO_2 concentration is highest if the indicator is

Volume 05, Number 01, March 2021, Page 11 - 16
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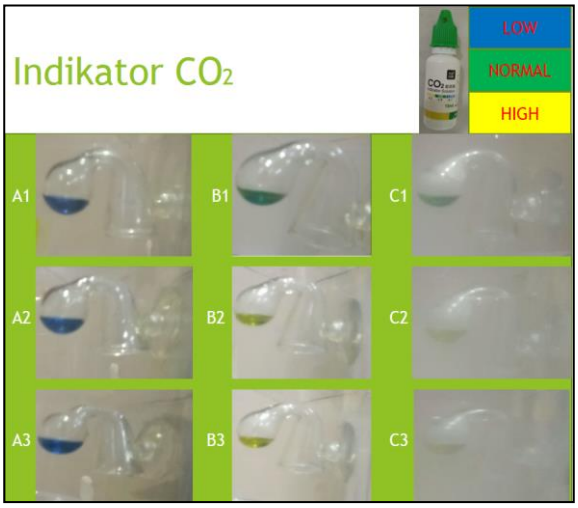
yellow. Figure 1 shows a significant color change in Box B and Box C. Treatment of carbon dioxide gas exposure without plants (Box C) produces a yellow color. This indicates that the combustion process produces high CO_2 levels. The treatment of carbon dioxide gas exposure in the presence of plants (Box B) gave the indicator a change in color to green and yellow green. The green color indicates that CO_2 levels are in normal conditions. The color change of the CO_2 indicator can be observed in Figure 1.



Information:
Box A = control treatment
Box B = greenhouse gas (CO_2) exposure treatment with the addition of plants
Box C = greenhouse gas (CO_2) exposure treatment without the addition of plants

Figure 1. Color change of CO_2 indicator in the Greenbox Effect Simulator experiment

Based on the color change, Box B turns green. This indicates that the carbon dioxide gas from combustion that is exposed can be absorbed properly by plants. Based on the color of the CO_2 indicator, orchids give green, Sri Gading plants give yellow green and Caisim plants give yellow. The green color in orchids indicates the ability of this plant to be the best compared to the other two plants in the ability to absorb CO_2.

Musfiroh's research **[19]** suggests that the absorption of CO_2 from trees in Lamongan Square is 3,323.55 g / tree / hour. Experiments using the Greenbox Effect Simulator show an increase in temperature ranging from 0.7 to 1.9 ^oC on exposure to greenhouse gases in the form of carbon dioxide. This temperature increase if it occurs in the environment can actually cause a lot of damage to nature and even death of organisms. Gottlib, et al., **[20]** stated that an increase in temperature of 1-2 ^oC (29-31 ^oC) from its normal temperature (22-28 ^oC) can cause a decrease in the calcification process in Stylophora pistillata and Millepora dichotoma. Bestion, et al., **[21]** stated that increasing air temperature can increase sea water temperature which will cause loss of phytoplankton biodiversity. The increase in temperature can also affect the primary productivity of the ecosystem which will decrease drastically and the loss of several species in the community.

Based on the experiment shows that the presence of plants can reduce the temperature rise. The presence of plants is proven to reduce carbon dioxide levels. Reduced greenhouse gas levels of carbon dioxide are indicated by the color of the CO_2 indicator and visibility of the Box. The presence of plants shows a green color, which means that the CO_2 concentration is at a normal amount. The presence of plants also increases the visibility of the Box, which means that the amount of CO_2 is reduced as a result of being absorbed by the plants. the presence of plants will ultimately reduce the temperature due to exposure to carbon dioxide gas. Plants function as temperature stabilizers, so that temperatures do not rise drastically.

The presence of plants has been shown to reduce levels of carbon dioxide greenhouse gases. However, current conditions indicate that tree growth is not proportional to the increase in accumulated greenhouse gases. The problem lies in the low rate of tree growth, while on the other hand, deforestation continues and various human activities produce greenhouse gases. CO_2 levels in the air can be neutralized by the presence of plants, both land and aquatic plants, such as seagrass and macrofites. Although the presence of plants can neutralize the amount of CO_2 in free air, if the CO_2 level in the air is too high it can have a negative effect on the plants themselves. At too high a CO_2 level, certain plants do not show an increase in photosynthetic performance. The interaction between temperature and photoperiod can exclude species from certain regions of the world's oceans. Changes in temperature can also have an impact on the amount of dissolved inorganic carbon components available for growth (Beardall et al. **[22]**). Temperature also affects morphology, physiology and behavior (Porter, et al. **[23]**). As Earth's climate warms up, interactions such as competition, predation, and mutualism change. Changes in the relationships between species, in turn, could drive important local scale changes in community dynamics, biodiversity, and ecosystem function, and could potentially alter large-scale distribution patterns and abundance (Kordas **[24]**). If the number of plants is not multiplied to compensate for the amount of CO_2 released into the free air, there will be negative feed backs that are detrimental to organisms and various ecosystems on earth.

The most effective awareness raising starts at the earliest possible age from the family, school and ward environment. Understanding the Greenhouse Effect material on Global Warming material in schools is one of the things that needs serious attention. The greenhouse effect is difficult to understand if only discussed at a theoretical level. Understanding the greenhouse effect will be better by presenting a simulation of the greenhouse effect and seeing its effects. The use of the Greenbox Effect Simulator tool is expected to help students understand firsthand the process of the greenhouse effect in a closed environment.

Understanding the greenhouse effect is important because it affects the future of the earth and humankind. Good understanding and application at the level of

Volume 05, Number 01, March 2021, Page 11 - 16
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government systems and daily lifestyles is the key to change for the better. Without a good understanding, it is not impossible that the future conditions will be worse. Lack of understanding and ignorance are things that need to be found a solution, so that the earth can still support biodiversity and all mankind.

IV. CONCLUSION

The greenbox effect simulator can function well to provide an overview of the greenhouse effect. In the greenbox effect simulator, it can be explained about changes in temperature for combustion activity, changes in the color of the CO_2 indicator, and changes in the level of air brightness (visibility). The presence of carbon dioxide greenhouse gases can be detected by three things, namely the temperature increase, the color change on the CO_2 indicator and the visibility of the Box. The presence of carbon dioxide gas from combustion will increase the temperature by 1.4 - 1.9 ^oC in Box C (without plants) and 0.7 - 1.5 ^oC in Box B (treatment with plants). The existence of plants reduces the rate of temperature increase because of the role of plants that can absorb CO_2 for the photosynthesis process. The best plants that can absorb CO_2 concentrations are orchids. The ability of orchids to absorb CO_2 is assisted by the presence of roots which also function to carry out photosynthesis.

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