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1 Greenhouse Effect Education Against Climate Change Through an Accelerometer-Based Android Game

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Abstract— Climate change has become a global issue, the greenhouse effect is the main cause of climate change. The greenhouse effect has an important role in keeping the earth's temperature warm. But greenhouse gases are increasing which is why global average temperatures continue to rise. These greenhouse gas emissions are caused by humans, such as the use of fossil fuels as an energy source, excess methane from livestock and burning forests as CO₂ absorbers. For this reason, how humans reduce greenhouse gas emissions such as switching from fossil materials to alternative energy, using public transportation rather than private vehicles, reducing meat consumption and so on. Education through games will learn all of this in different ways, using the accelerometer as the main control is a challenge for players. This paper has purpose how to arrange the greenhouse effect material in the form of an Android-based game. Game testing data through submitting several statements to respondents. Questionnaires were distributed to respondents who had directly played this game. After testing the game, it is found that the convenience variable and the pleasure variable have a correlation with the desire to return to use.

Keywords— Climate Change, Greenhouse Effect, greenhouse gas emissions, Education, Games, accelerometer

I. INTRODUCTION

The greenhouse effect is a major cause of climate change. Excessive air pollution which increases the greenhouse effect. The increasing greenhouse effect starts from the

emergence of the industrial revolution in which the transition from animal and human power to machine power. During the industrial evolution period in the 1850s, the heat trapping emission or greenhouse effect was around 865 megatons to 46.6 gigatons in 2015 [1]. changing weather, drought, rising sea temperatures, rising sea levels caused by melting ice, rainfall such as rain and snow.

These greenhouse gases include carbon dioxide (CO₂), Nitro Oxide (NO_x), Sulfur Oxide (SO_x), Methane (CH₄), Chlorofluorocarbon (CFC) and Hydrofluorocarbon (HFC) [2]. Greenhouse gases, especially carbon dioxide and methane, are the two main things that occur in the lower atmosphere layer [3]. Carbon dioxide comes from fossil fuels which are commonly used as fuel for vehicles and power plants, and also methane gas from livestock manure [4]. Climate change, such as an increase in the frequency of rain with very high intensity, an uncertain rainy and dry season, an increase in sea level. The rise in sea water is caused by increasing sea temperatures which causes expansion of sea water volume, and also the melting of mountain glaciers and ice cover [5]

The greenhouse effect greatly affects the condition of seawater, the increase in sea water temperature is a serious problem even the results of world ocean research save more than 90% of heat energy stored in carbon emissions by getting warmer seawater, oxygen levels in sea water decrease and can affect marine ecosystems [6]. According to Dr Jevrejeva of the NOC if the earth's temperature were to increase by 2 degrees Celsius the sea level could increase to 0.86 meters and at worst 1.8 meters, this could

cause the world to suffer huge losses, losses could reach \$ 14 trillion by 2100 next [7]. Even warming sea water temperatures affect wind power plants, warming water in the Indian Ocean weakens the Indian monsoon, even over the last 40 years the potential for wind has decreased by 13% [8].

Climate change has become a real event that has happened for a long time, one of the main actors of this event is humans themselves. But not a few humans do not realize they are the perpetrators of climate change. The YouGov-Cambridge Globalism Project has conducted research and shown that 18% of Indonesians do not believe that the main actors of climate change are humans themselves[9]. The survey involved 25,000 people from all over the world, where Indonesia was ranked first to distrust the main actors of climate change [10].

The main contribution of greenhouse gas emissions is electricity generation and transportation, and it is even estimated that currently greenhouse gas emissions from the power generation sector have reached 1/3 of global emissions. Other greenhouse gases come from human activities, such as industrial activities, burning biomass, deforestation, burning land for development and other activities [11]. Basically the result of burning fossil fuels is carbon dioxide gas (CO₂).

Livestock accounts for 18% -51% of anthropogenic greenhouse gases, most of which is methane gas (CH₄) [12]. CH₄ is formed from anaerobic metabolism, CH₄ is usually anthropogenic, and also CH₄ also accounts for 21%, 15% and 8% of greenhouse gas emissions, respectively. Although it produces relatively small greenhouse gases, CH₄ has a global warming potential 25 times greater than carbon dioxide gas (CO₂). There is a scientific report that states that the European livestock sector has exceeded the safe limit for the production of greenhouse gas emissions, reported by The Guardian. For this reason, it is urged to reduce meat consumption in order to reduce population growth and global income on the demand for meat-based products [13].

Table 1 gas table of global warming potential

Gas	Dwelling Time in the Atmosphere (Years)	Global Warming Potential (CO ₂ -eq) *	Global Warming Potential (CO ₂ -eq) **	Global Warming Potential (CO ₂ -eq) ***
CO ₂	5-2000	1	1	1
CH ₄ *	12	21	23	25
N ₂ O**	144	10	296	298

Number : *IPCC 2nd Assesment report, 1995
 **IPCC 3nd Assesment report, 2001
 ***IPCC 3nd Assesment report, 2007

The game with the theme of the greenhouse effect will be based on android, the game control will take advantage of the accelerometer to play the game. The accelerometer sensor converts the acceleration into an electrical quantity that can be used in an electrical circuit [14]. The accelerometer sensor has 3 axes, namely X, Y, Z, which have different eels which are adjusted to the point of gravity [15]. The X axis describes the rotation of the axis, the Y axis describes the slope of the Y axis, the Z axis describes the movement of turning or bending over the plane.

There are various game features that are not only for entertainment but also for none thinking and logic that can introduce material to be more interesting to be accepted and understood [16]. The educational game on the theme of the greenhouse effect will form the basis of the game. The form of education that is delivered through games. Education about the greenhouse effect on climate change that players can explore. This game will put on the cause, impact and overcome the greenhouse effect. This game will be based on android using the Accelerometer as the main feature of the game.

In this study, three problem formulations will be analyzed, namely, How about introducing the greenhouse effect in a different way? How about making a game with the theme of the greenhouse effect?, How do you see the effect of the game on the player?

II. METHOD

A. Data Source

Sources of data are obtained from various journals, theses, articles related to the material

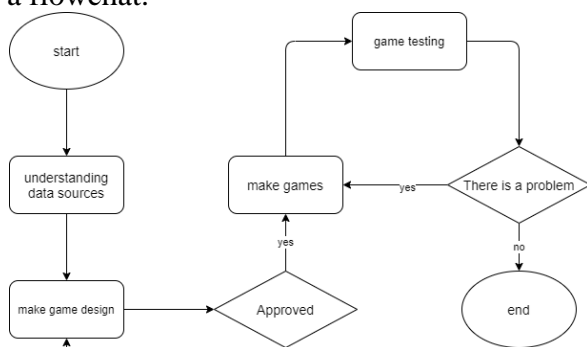
that will be used for game development.

B. Questionnaire Data Collection

The technique of collecting data is through submitting several statements to respondents. Questionnaires were distributed to respondents who had directly played this game. Where the target respondents are junior high school children and above.

C. Design Process Method

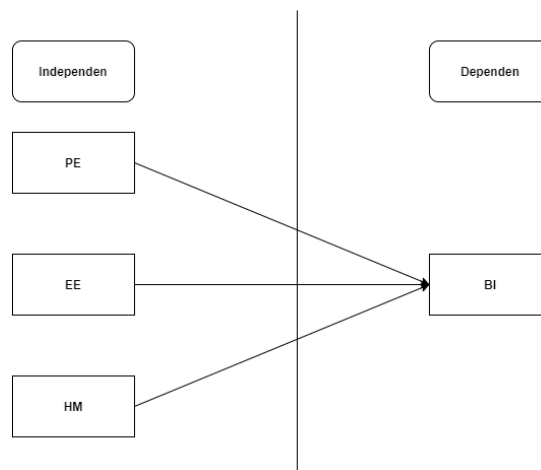
The research begins with collecting data from various journal articles and books to find the concept of the main problem, then the design is determined based on the predetermined concept of the subject matter. If the game design has been approved, it will proceed to the game creation process. Figure 1 describes the research process in the form of a flowchart.



Figures 1. the design process

D. Testing Method

Testing is done by using 3 kinds of tests, namely validity test, reliability test, and testing. Where to see whether the results of the questionnaire are valid, reliable, and interrelated or not. Figure 2 explains the independent and dependent relationship with the PE, EE, HM testing variables. Where is PE (usability), whether this game will be useful for players to add insight, see if the game is implemented easily as learning, and HM (fun), see whether the game is fun to play or not. The variables PE, EE, and HM will affect BI, namely the intention of behavioral behavior whether to use this game as learning or not.



Figures 2. Variable relationship

III. RESULT AND DISCUSSION

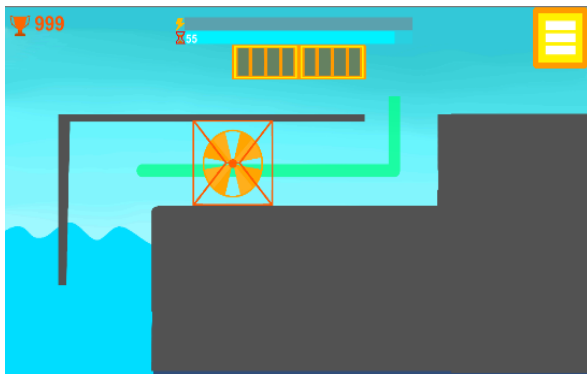
A. Game Concept

A game called "greenhouse effect" is designed to gain insight into the greenhouse effect, its impacts, causes and how humans deal with it. This game is designed in several stages that have different themes and gameplay, with different difficulty levels which are expected to make players feel bored.

The game "greenhouse effect" has 7 stages with 5 different gameplay. Each gameplay has a different theme around the greenhouse effect, plus an additional 1 game in the form of a true false quiz containing questions about the material contained in the game, which can see the extent to which the player understands the game material.

In the first gameplay, the theme of alternative energy is where players have to move right and left to move the generator to full energy within the specified time limit. This gameplay is on stage one, two, and five.

Game stage 1 with the theme of alternative energy powered by sea waves as shown in Figure 3. Using the accelerometer to rotate the turbine to produce energy.



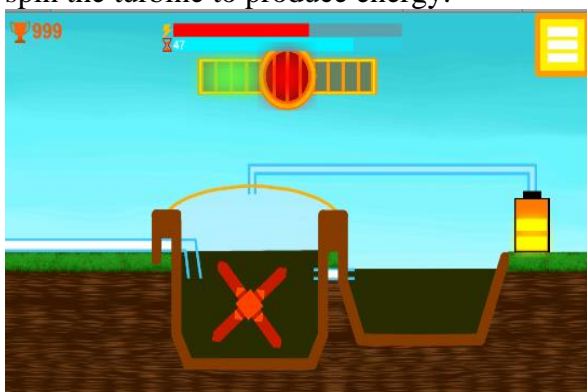
Figures 3. stage 1 - alternative energy

Game stage 2 with the theme of alternative energy powered by wind as shown in Figure 4. It has the same gameplay as stage 1 where it uses the accelerometer to rotate the turbine to produce energy.



Figures 4. stage 2- alternative energy

A stage 3 game with the theme of alternative energy using livestock manure as shown in the picture. Has the same gameplay as stage 1 where it uses the accelerometer to spin the turbine to produce energy.



Figures 5. stage 5 - alternative energy

In the second gameplay, the theme of meat and methane emissions is shown in Figure 6. Accelerometer Use to select the amount of meat to be produced by tilting right and left to select, large meat has a large value but has

large methane emissions and meat small ones have a small value but have small methane emissions. Here the player has to determine the score determined within the time limit and also the methane emissions must not exceed that limit. The game is in the third stage.



Figures 6. stage 3 - meat and methane emissions

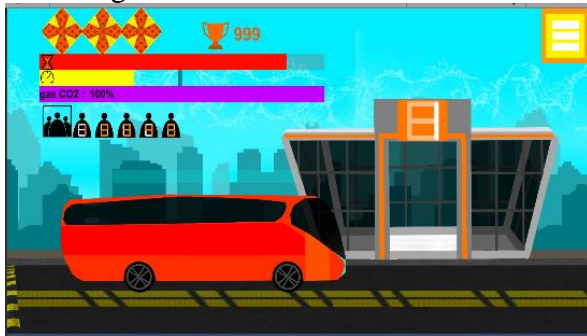
The third animal, the theme of dirt and alternative energy. The game display is shown in Figure 7. The game will collect cow dung within the specified time limit. Here, players must also pay attention to cows, cows must not starve if the cow dies of hunger then the game will be over. To dry the dirt removal machine, simply tilt the phone from side to side. The game is in stage four.



Figures 7. stage 4 animal waste and alternative energy

In the fourth gameplay, with the theme of motor vehicles and CO2 emissions. The game display is as in Figure 8 where the player will control the bus to lower the passengers by tilting it to the right to increase the speed and tilting it to the left to decrease the speed. In this gameplay there is an incline if the bus goes fast on an incline it will lower the emblem. If the emblem is less than three, there is a possibility that the CO2 emission bar will not decrease after dropping off the passenger because the passenger feels uncomfortable

with bus services. This gameplay is in the sixth stage.



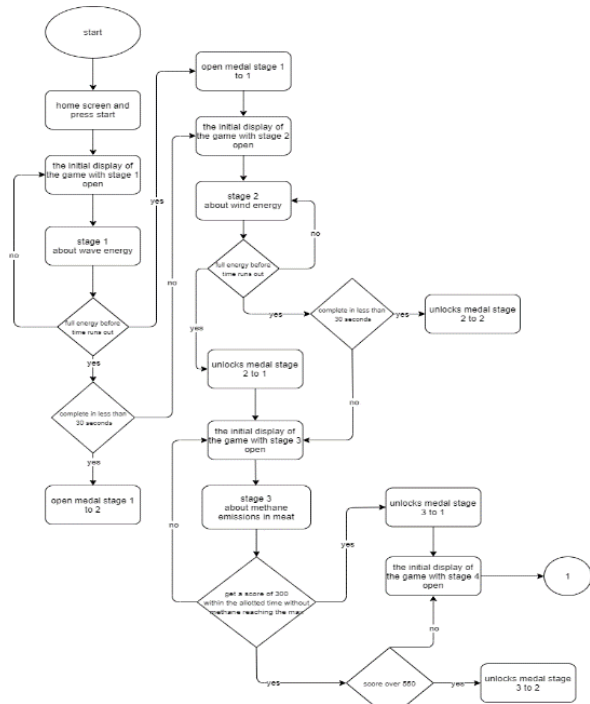
Figures 8. stage 6 - motorized vehicles and CO2 emissions

In the fifth gameplay, the theme is to extinguish forest fires. The player will play the fire engine. The game view is shown in picture 9, the player must extinguish all the burning trees before the CO2 emission bar is full. To move the machine, it is enough to tilt the cell phone and the machine will move to the tilt of the cell phone. The machine will take damage if it is touched by fire, and if your health reaches zero then the game fails. This gameplay is in the seventh stage.



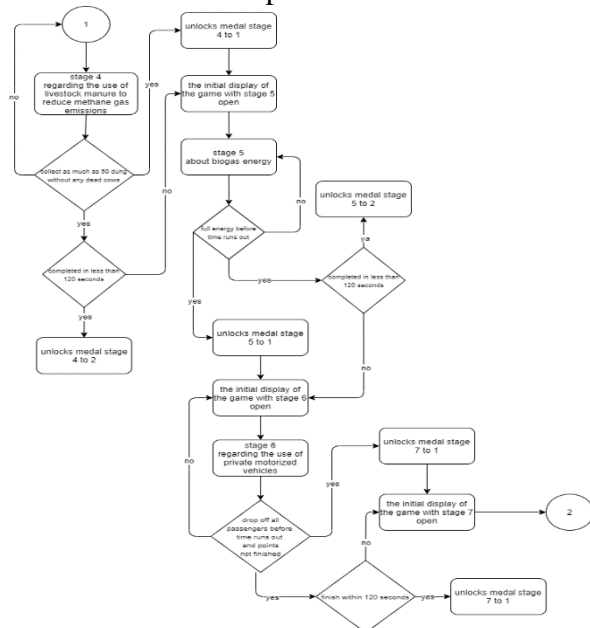
Figures 9. stage 7 - extinguish forest fires

Figure 10 shows a flowchart explaining the game process from stage 1 to stage 3, how to complete each stage to unlock the next stage and how to unlock special achievements. On stage 1 and stage 2 players must collect energy at a certain time limit to open the next stage, on stage 3 players must collect as many as 300 points at a predetermined time limit without exceeding methane emissions to open the next stage.



Figures 10. flowchart game "greenhouse effect" 1

Figure 11 shows a flowchart explaining the game process at stage 4 to stage 6, how to complete each stage to unlock the next stage and how to unlock special achievements.

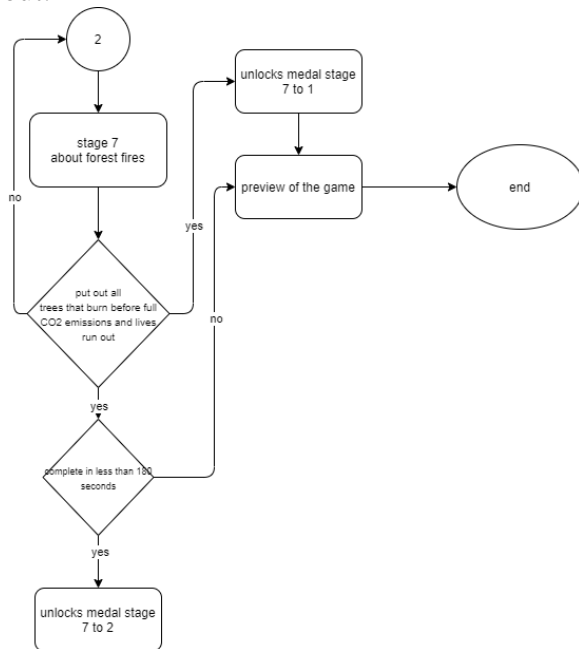


Figures 11. flowchart game "greenhouse effect" 2

At stage 4 the player must collect cow dung without letting the cow die of starvation to open the next stage, at stage 5 the player must collect energy at the time limit to open the next stage, on stage 6 the player must lower

all passengers within a predetermined time limit and point value can't run out.

Figure 12 shows a flowchart explaining the game process at stage 7, how to complete each stage to unlock the next stage and how to unlock special achievements. in stage 7 the player must extinguish all the trees before the CO2 emission is full or the player's life runs out.



Figures 12 flowchart game "greenhouse effect" 3

a. Respondent Data Analysis

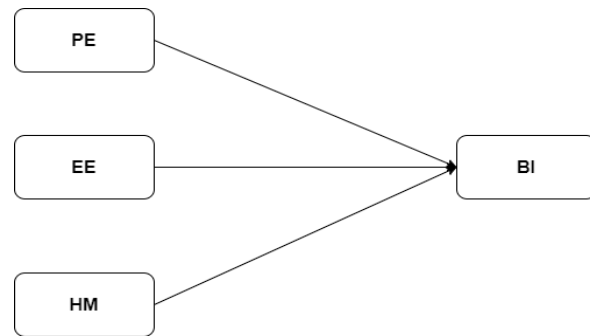
After testing the game and collecting data by distributing questionnaires to over 75 people aged 16 years and over, the following results were obtained:

Profile of Respondents

1. Age
Most respondents are aged 20 years with a total of 18 people.
2. Gender
Most respondents were male as many as 63 out of 82 respondents and female as much as 19 out of 82 respondents.'

Discussion of Questionnaire Data

The results of the questionnaire data are based on 4 supporting variables, namely EE (convenience), PE (profit), HM (pleasure), and BI (periodic use) which can be seen in Figure 13, where PE, EE, and HM can affect BI or not.



Figures 13 relationship variable

b. Validity Test

Table 2 shows the validation of the questionnaire which can be seen that all variables have a value above 0.7, which means that all data are valid. The data obtained were the BI variable which was grouped with a value of 0.956-0.945, the EE variable which was grouped with a value of 0.958-0.938, the HM variable which was grouped with a value of 0.978-0.945, and the PE variable which was grouped with a value of 0.94-0.902.

Table 2 Table of validity test results

	BI	EE	HM	PE
BI1	.945			
BI2	.956			
BI3	.945			
EE1		.958		
EE2		.943		
EE3		.943		
EE4		.938		
HM1			.946	
HM2			.978	
HM3			.953	
PE1				.940
PE2				.935
PE3				.902

c. Reliability Test

Table 3 shows all variables above 0.9, which means that the internal consistency is excellent, which means that all variables can be accounted for.

Table 3 Table of reliability test results

VARIABLE	CRONBACH'S ALPHA	INTERNAL CONSISTENCY
PE	0.919	Excellent

VARIABLE	CRONBACH'S ALPHA	INTERNAL CONSISTENCY
EE	0.960	Excellent
HM	0.957	Excellent
BI	0.944	Excellent

d. Uji Hipotesa

From table 4, it is found that the HM variable is correlated with BI because P Values $0 < 0.05$ or T Statistic $11.307 > 1.990$, the EE variable is correlated with BI because P Value $0.038 < 0.05$ or T Statistic $2.078 > 1.990$, and PE variable does not correlate with BI in because P Values $0.977 > 0.05$ or T Statistic $0.028 < 1.990$.

Table 4 Table of correlation test results

	Original Sample	Sample Mean	Standar Deviation	T Statistic	P Values
HM->BI	0.676	0.677	0.060	11.307	0.000
EE->BI	0.162	0.161	0.078	2.078	0.038
PE->BI	-0.002	0.001	0.083	0.028	0.977

which means that the ease of playing the

In table 4, the hypothesis model is obtained, PE variable (usability) does not correlate with BI variable (willingness to play it back) because the respondent feels that the usefulness of the game do not give the respondent the desire to play it back. EE variable (convenience) correlate with the BI variable (desire to play it back) because the respondent feels that the ease of playing gives the respondent the desire to play it back. variable HM (pleasure) correlates with the BI variable (desire to play it back) because the respondent feels that the fun of the game gives the respondent the desire to play it back.

IV. CONCLUSION

The conclusion from the research results of the "greenhouse effect" game is:

1. The design of the "greenhouse effect" starts from studying material from articles, journals and theses. Then make a gameplay design that represents each theme in the game that is still related to the material.
2. The game "greenhouse effect" uses the accelerometer on an Android smartphone as the main control in the game. With the accelerometer the player simply tilts the android smartphone in a certain direction to play it.
3. The results of testing the game "greenhouse effect" through testing and questionnaires to the respondent concluded that EE and HM are correlated with BI,

game "greenhouse effect" and the fun gained from playing the game "greenhouse effect" has a relationship with the desire to continue playing. game "greenhouse effect". And PE is not correlated with BI, which means that the benefits or use of the game "greenhouse effect" does not have a relationship with the desire to continue playing the game "greenhouse effect".

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