"LET'S GO GREEN"
MOBILE GAME/APPLICATION FOR GLOBAL WARMING AWARENESS

by

YVES LOJIU

Dissertation submitted to the

Information & Communications Technology Programme

Universiti Teknologi PETRONAS

In partial fulfillment of the requirement for the

BACHELOR OF COMPUTER & INFORMATION SCIENCES (Hons)

(INFORMATION & COMMUNICATIONS TECHNOLOGY)

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Universiti Teknologi PETRONAS

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Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Approved by

_____

Prof. Dr. Alan Oxley

University Teknologi Petronas

TRONOH, PERAK

August 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Yves Lojiu

ABSTRACT

The objective of the project is to create an interactive game which can create awareness of the carbon footprint and the effect of global warming at an individual level. The game is aimed to be used on mobile platforms such as Android devices including tablets, due to the current population trend with smartphones and the like. The game would comprise of 2 main working parts, the game itself, and the carbon calculator which calculates ones carbon footprint based on the input received during the course of the game.

The concept for this kind of awareness tool is taken from the availability of many carbon calculators out there, and the global warming phenomenon. Alone, the carbon calculator is a very useful tool but it is often treated like the traditional calculator, where it is only used when needed. A different approach must be used to penetrate the current generation's mindset to raise awareness of global warming.

The project was initiated by analysis of the main problem and the objectives of the project. Further research was done on articles and online resources related to the problem; a literature review was therefore derived.

Other materials were researched, online Android developing kits and carbon footprint formula's which is crucial to the project. To create the embedded calculator, the formula would be needed and for the game/interface, Android development must be researched to be able to create the game itself.

It is important to fully understand what is need to create a good carbon footprint calculator, and how it should be demographically customized. How the calculator is customized also contributes to the build of the game because the game will be designed to accept inputs that would be used in the calculator to produce an individual's carbon footprint.

The methodology for this project would be Rapid Application Development (RAD) methodology, since the project is expected to be result-oriented and would require the repetition of certain phases to come up with a workable prototype of the game.

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Chapter 1: Introduction

1.1 Project Background

The term carbon footprint generally means the impact of ones activity on the environment, which means the climate change. A carbon footprint relates to the volume of greenhouse gases (GHG) that is produced by a person throughout their daily life. Daily activities such as commuting, using electricity, or even cooking can contribute to the production of GHG.

Carbon calculators calculate the carbon footprint of an individual based on a number of inputs such as monthly electricity bills, petrol and gas usage, and so on. Instead of pointing fingers at big corporations and industries which do contribute greatly to climate change and emissions of GHG, carbon footprints provides individuals with the impact of their daily lives on the environment, so that actions can be taken on an individual level. With over 7 billion people living in the world today, if everyone took part in reducing their GHG emission, there would still be hope for the future.

In a digital generation, the best way to reach out to the crowd would be through the digital world. A movie or documentary on climate change or global warming might have sufficed to create awareness but due to the negligence and ignorance of many people, GHG emissions are still rising. It could be that people felt like the problem was too big for any of them to handle, thus ignoring it completely, but with carbon footprint studies, individuals can do their part for the environment. In addition, the game interface would make it much easier and interesting to use and effects on the environment can be emulated in the scenario where either it's the end of the world, or the efforts of individuals managed to save the world.

The combination of a game and the carbon calculator is a different approach to merely just calculating ones footprint. The challenge would be to attract potential players with a comprehensive gaming package, and then creating a way to communicate the effect of the calculated carbon footprint and what can be done to reduce it.

The game would be developed in an Android environment to match the trend of smartphones where people download games and play. This way, the message would

reach a large crowd and the message would be much clearer and specific to the individual.

1.2 Problem Statement

Global warming is caused by emissions of greenhouse gases (GHG) which trap heat within the Earth's atmosphere, and carbon dioxide erodes the ozone layer, allowing the sun's harmful rays to penetrate heat the Earth further. The main problem is not just the lack of awareness, but not knowing who is responsible and what can be done to help remedy this issue.

According to an article, "Top-Emitting Countries Differ on Climate Change Threat", by Anita Pugliese and Julie Ray dated 2009, a poll was made about the awareness of global warming according to countries:-

Public Awareness and Opinion of Climate Change

Among the top five emitters of greenhouse gases

	Aware of climate change	Aware and serious personal threat	Aware and not serious personal threat
Japan	99%	80%	19%
United States	97%	63%	35%
Russia	85%	39%	36%
China	62%	21%	38%
India	35%	29%	5%

2007-2008

GALLUP

Figure 1: Public Awareness and Opinion of Climate Change Poll

From the poll, it can be seen that although aware of global warming, one third of the population of countries aside from Japan do not see this as a serious problem, although being the top emitters of GHG. It can be deduced that although people are aware of this happening, but they still do not see the connection of their actions and global warming itself. Since this poll was taken from 2007 to 2008, China has been rising as an industrial player with a booming population and global investments in

manufacturing facilities in its country. This also applies to all other countries, including Malaysia. The rising temperature and increasing numbers of natural disasters just proves that global warming is real and just being aware is not enough. Actions must be done if this issue is to be dealt with.

1.3 Objectives

1. To create an interesting educative game/application which can raise awareness on global warming at an individual level
2. To provide a means to measure one's carbon footprint which can be used to reduce ones carbon emission

1.4 Scope of Study

The scope of this study will cover the feasibility of using mobile games as an educative learning tool, and the availability of the tools/information needed on developing an Android platform game with an embedded carbon calculator.

Android development will also be included in scope of study, which encompasses game development, Android compatibility, game publishing on Android market and attractive game design based on market trend.

1.5 Significance of Project

According to an article "Global Warming Fast Facts" from National Geographic website, updated June 2007, average temperatures have climbed 1.4 degrees Fahrenheit (0.8 degree Celsius) around the world since 1880, much of this in recent decades, according to NASA's Goddard Institute for Space Studies. This clearly shows that global warming is not a myth and the situation is getting worse because in 2007, temperatures have risen, and in 2010, carbon dioxide emissions (worldwide) reached a record high according to the International Energy Agency website (article updated May 30, 2011). Carbon dioxide emissions measured from 1950 to 2050 show frightening figures, (Richard Schmalensee, Thomas M. Stoker, and Ruth A. Judson, 1998).

On the other hand, games to be used as learning tools is debatable, but time has proven otherwise as more people are looking into this theory, and in fact already using it. Games have a captivating effect that can keep a human engaged in it for hours, compared to lecture sessions which cannot do the same. Although the abundance of global warming information and tools to help see what impact one has on the environment, the lack of attractiveness restricts it from being spread out to modern society.

Effective game design combined with proper carbon dioxide calculations (carbon footprint calculator) can be used as a tool to raise awareness to a big target audience, the mobile applications market.

In the 21st century, smartphones are quickly becoming the must-have trend, where big companies such as Samsung, Apple, and HTC are manufacturing high performance phones which rival the computing power of an average laptop. The availability of development platforms for these smartphones i.e. Android and Apple allows the average person to create applications which can be downloaded from a digital market to be used on an individual's smartphone.

Statistics will be show in the next page that can further clarify the feasibility of choosing a mobile application market to generate awareness in this century.

Worldwide smartphone market, by operating system, by 2011 global sales according to Canalys			
Operating System	**Shipments 2011 (millions)**	**Market share 2011**	**Annual growth**
Android	237.7	48.8%	244%
iOS	93.1	19.1%	96%
Symbian	80.1	16.4%	-29.1%
BlackBerry	51.4	10.5%	5.0%
Bada	13.2	2.7%	183.1%
Windows Phone	6.8	1.4%	-43.3%
Others	5.4	1.1%	14.4%
Total	487.7	100%	62.7%
Source: Canalys (Feb 2011)			**via:** mobiThinking

Figure 2: Smartphone Sales according to Operating System

Retrieved from http://mobithinking.com

As shown above, the sales of Android devices are astounding and obviously, this is one of the plausible platforms to push for global warming awareness due to the number of potential audience it can reach.

Chapter 2: Literature Review

2.1 Introduction

In this section, a few papers/articles relevant to the project have been acquired for literature analysis. The first paper is related to carbon dioxide and its future projections. This is significant to prove the feasibility of a "green" IT project where there is an inevitable need for efforts that can curb global warming. The second paper is related to games as educational tools. This is significant to prove whether or not a game is the best way to go about spreading global warming education. The online reference (website) explains carbon footprint, which is the basis of the project; to calculate carbon footprint which equals to ones impact on the environment.

2.2 Literature Reviewed

"WORLD CARBON DIOXIDE EMISSIONS: 1950–2050" by

Richard Schmalensee, Thomas M. Stoker, and Ruth A. Judson

The paper above describes the projection of carbon dioxide, a greenhouse gas which damages the ozone layer and traps heat within the Earth's atmosphere, in years 1950 to 2050.

The authors used economic statistical methods to compute graphs which find the connection between the countries' Gross Domestic Product (GDP) and how much carbon dioxide that country emitted. Based on the graphs, the higher the GDP, the more carbon dioxide produced by that country.

The paper also aims to challenge the Intergovernmental Panel on Climate Change (IPCC) on its projection of carbon dioxide emissions from 1950-2050 which was calculated based on historic benchmarks. From their calculations (using the same data from IPCC) the newly derived graph depicts a significant difference which shows that more carbon dioxide will be emitted compared to the one from IPCC.

The paper is basically a statistical study of carbon dioxide emissions in years to come, and to show the trend of productivity versus carbon dioxide emissions. All

calculations are estimates, and not fully accurate, due to the many factors to be considered relating to future events, such as possible oil shocks.

"Educational Video Game Design: A Review of the Literature" by

Mary Jo Dondlinger

The article studies whether or not the games can be beneficial for learning, and the theories of learning that can explain why games can foster learning. It focuses on the design of the game, how the game educates its player instead of what players learn from games.

The review discusses elements of effective video game design, which includes motivation, narrative context, goals & rules, interactivity and multisensory cues. Analysis of previous literature proves the significances of these elements towards an effective game design, and makes a game interesting or not in the eyes of the player.

The theories of learning that are studied include constructivism, constructionism, and situated cognition; these theories are for video games, and how players can learn from video games.

Research cited in the article suggest that learning outcomes from games include modern skills, deduction, hypothesis testing, complex concepts, visual and spatial processing.

In conclusion, games can be designed in an educational way. Games can promote learning, although there are opposing opinions about this.

Online Websites - http://www.carbonfootprint.com/carbonfootprint.html

From the full link above, the information retrieved describes carbon footprint. There are two categories of carbon foot prints, primary which directly involve the person (e.g. car usage) and secondary which indirectly involves the person (e.g. manufactured products purchased). There are also other services provided such as a carbon calculator and consultation about carbon footprint.

The link also shows a pie chart with the main factors contributing to a person's carbon footprint.

Chapter 3: Methodology

3.1 Introduction

RAD is a result-based methodology, developed to respond to the need to deliver systems very fast. The RAD approach might not be applicable to all projects – much research would be needed for a traffic control system and RAD would be inappropriate. A projects scope, size and circumstances would determine the effectiveness of using a RAD approach.

This project scope is specific; a game with an embedded carbon calculator. Deadline for the project is within 8-9 months, in which the project will be worked on part-time. Most probably project work will occur at random hours of the day every week and also whenever possible (free time). The goal of the course is to produce a working prototype with an impact, therefore RAD is most appropriate.

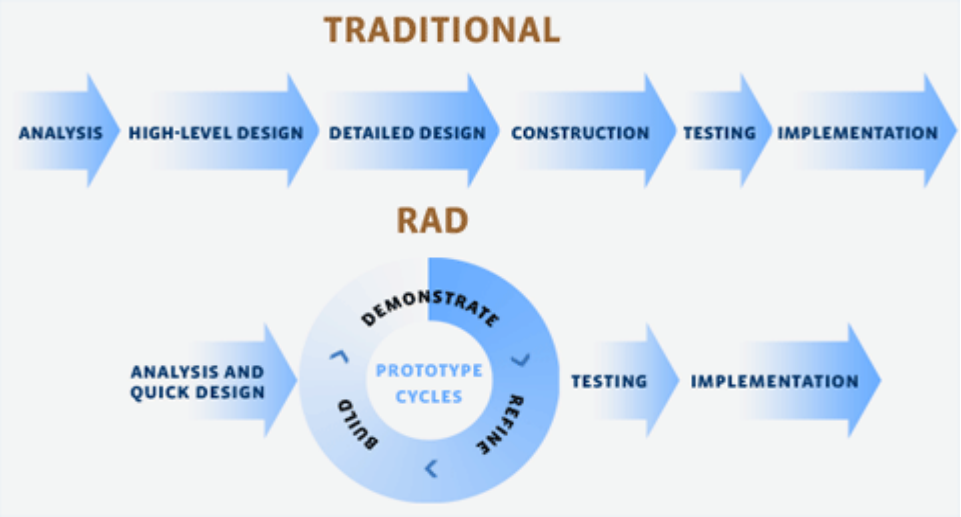

Figure 3: Rapid Application Development

Source: http://www.rootsitservices.com/CustomPages/sdlifecycle.aspx

The figure above shows the difference between the traditional method and RAD, and how a project phase is handled. This project phases will be divided to:

- Project Analysis and Requirements Gathering
- Project Design
- Project Development
  - Implementation & Testing
- Project Deployment

3.2 Project Activities

3.2.1 Project Analysis and Requirements Gathering

In this phase, research and study has been conducted in relevance to project objectives and scope of study. The purpose of this is to compile relevant documents and information into outputs that can be presented to Final Year Project supervisor for approval/suggestions on project.

Approval is crucial before development so that objectives set are feasible; a project with no meaning or without the means to proceed is not encouraged for Final Year Project. This phase also allows for early corrections or additions to be made for the project design/plan such as game design & concept, formula usable, etc…

Literature reviews are useful information that can prove feasibility of project, and assist in designing and conceptualization of the project deliverables.

Data Gathered

1. Global warming information and articles
2. Carbon footprint information and formula
3. Potential game development engines
4. Tools to be used

Software Procured

Game development engines procured were:

1. **Unity 3D Development Kit** (Stand-alone)
    - This engine focuses on 3D game development, especially for desktop gaming and console.
    - Allows 3D game development to be run in a smaller scale, fitting Android OS requirements. E.g. Android games.
    - Requires purchase of license to produce an application/game to be uploaded to the Android Market or now Google Play Store.

- Games are developed within the software's interface, and require knowledge of 3D modeling and basic gameplay such as camera positions and story line.
- Can produce high resolution 3D game with sufficient time, knowledge, skills and resources (finance).

2. **Unreal Development Kit** (Stand-alone)
   - Similar to Unity, Unreal is also a 3D game development engine. This is the same engine that is used to run the Unreal Tournament game.
   - License also required, if game produced reaps profit over a certain amount. If this criterion is satisfied, the developer will have to pay a certain amount of money to the Unreal Company.
   - Also allow games to be developed to run on Android or IPhones.
   - Games are also developed within the software's interface, and require knowledge of 3D modeling and basic gameplay.
   - Games produced using this engine have high graphics and 3D environment.

3. **AndEngine** (Plugin/Library-based)
   - Very different from Unity and Unreal.
   - Free
   - Requires "Eclipse IDE for Java developer" software to develop game
   - The engine is made up of many libraries that make up the code
   - Development is done via code and not interface
   - Lack of documentation and proper tutorials; hard to learn

After learning and testing using these engines, AndEngine was chosen to develop the game due to the factors; free, background in Java programming, and usable examples to implement in the actual game.

Other software:

MIT App Inventor Beta (Browser Based)

This software is run via internet browser such as Google Chrome or Mozilla Firefox. The carbon footprint calculator will be developed and tested using this software due to the fast development rate and the ease of use. The interface will be explained in the development environment section.

3.2.2 Project Design

Basic Application Flowchart

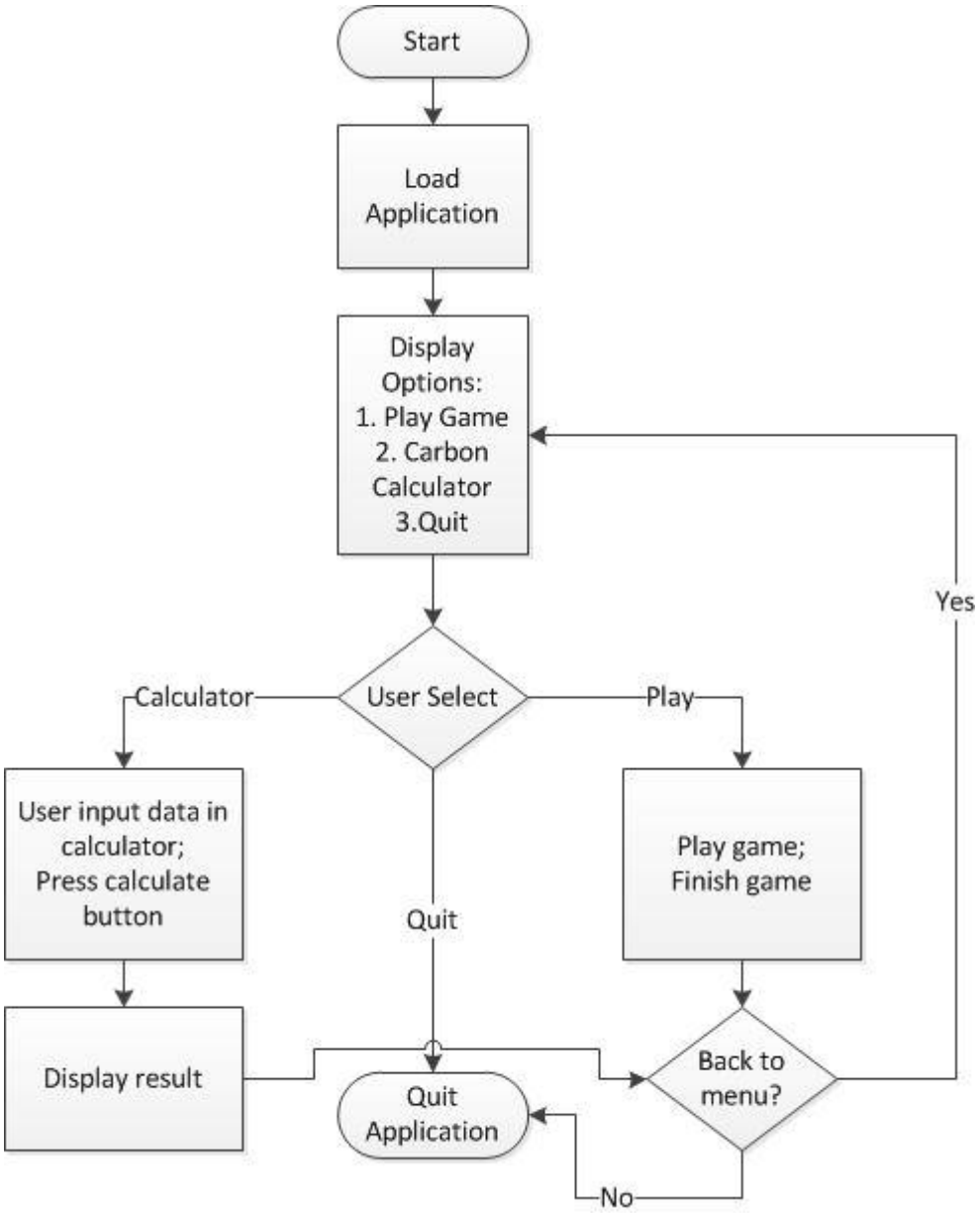

Figure 4: Proposed application flowchart

The flowchart above describes the flow in the application to be delivered. It would be a single application, capable of running both the calculator and the game.

1. First scene would be menu showing the three options; Game, Calculator & Quit.
2. User is free to select any option.

3. Upon selecting calculator, user can calculate their carbon footprint in a monthly basis. Upon seeing result, user can go back to menu to choose other option, or the user can quit the application.
4. Upon selecting game, user can play the game which will use global warming and carbon dioxide emission as the concept. After finishing the game, user can go back to menu to choose other option, or the user can quit the application.

3.2.3 Project Development

Development Environment

The game is being developed using **Eclipse IDE with AndEngine** as the game engine. The carbon footprint calculator is developed using **MIT App Inventor Beta.**

Eclipse IDE for Java Developer

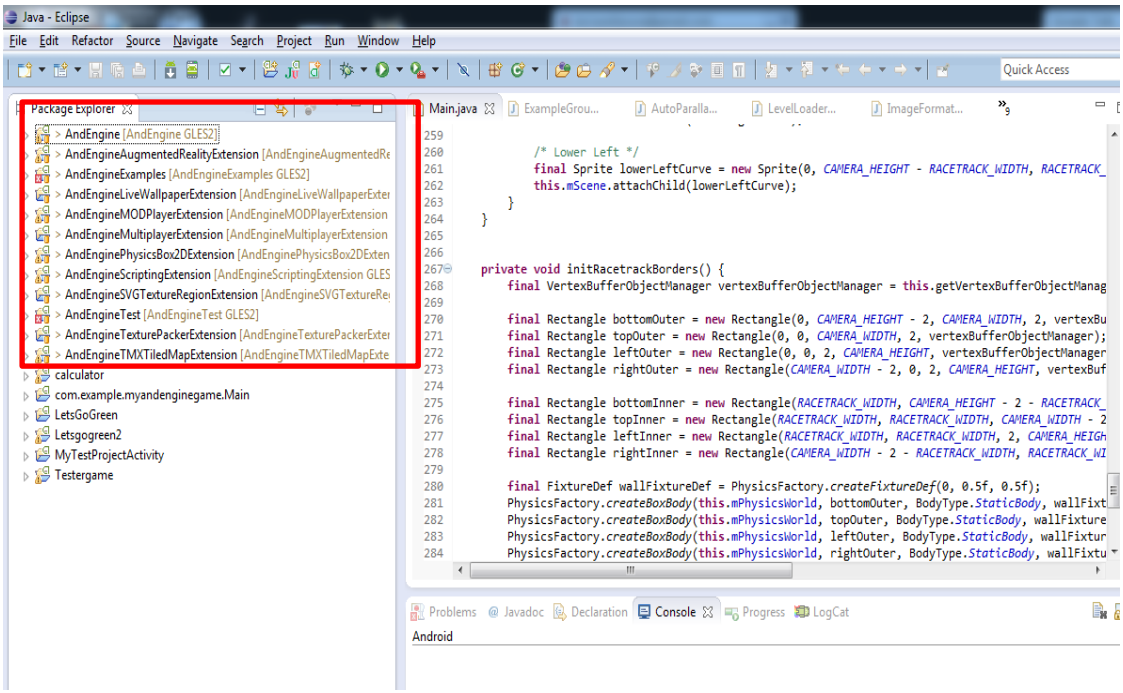

Figure 5: Eclipse IDE interface

The figure above shows the interface of **Eclipse**. This development tool uses the **Android Software Development Kit** and the **Android Virtual Device** plugins to generate a code-based development environment. The code can then be transformed into a working application and tested on an **Android Virtual Device** emulator or a plugged in via **USB** Android device.

As depicted by the square, this is the **AndEngine** libraries which have been imported into **Eclipse**. Any project within **Eclipse** can use these libraries to implement game functions such as cameras, physics, and many more.

MIT App Inventor Beta

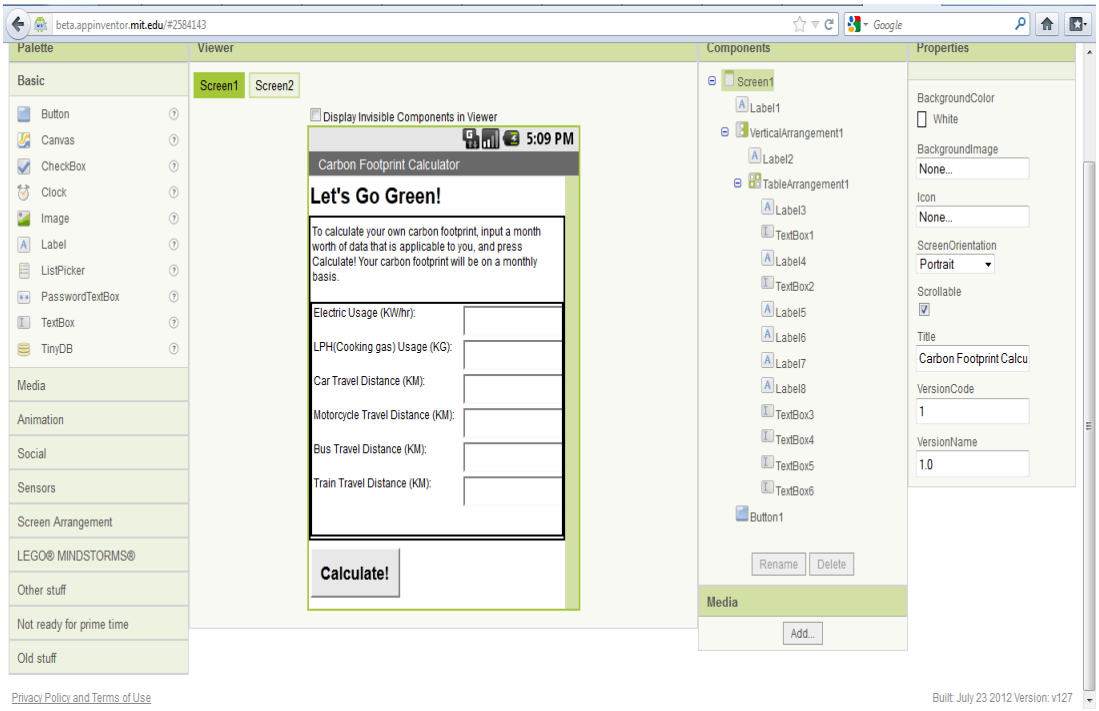

Figure 6: MIT App Inventor

The figure above shows the interface of **MIT App Inventor Beta** which is used to develop the carbon footprint calculator application. The environment is similar to Visual Basic, where visual objects can be dragged and dropped to the device screen to create a working application.

MIT App Inventor Beta provides a RAD environment to produce a working prototype of the calculator, which needs to be tested in the real environment. The next figure will show how working logic is implemented onto the interface generated by **MIT App Inventor Beta**.

MIT App Inventor Beta (Blocks Editor)

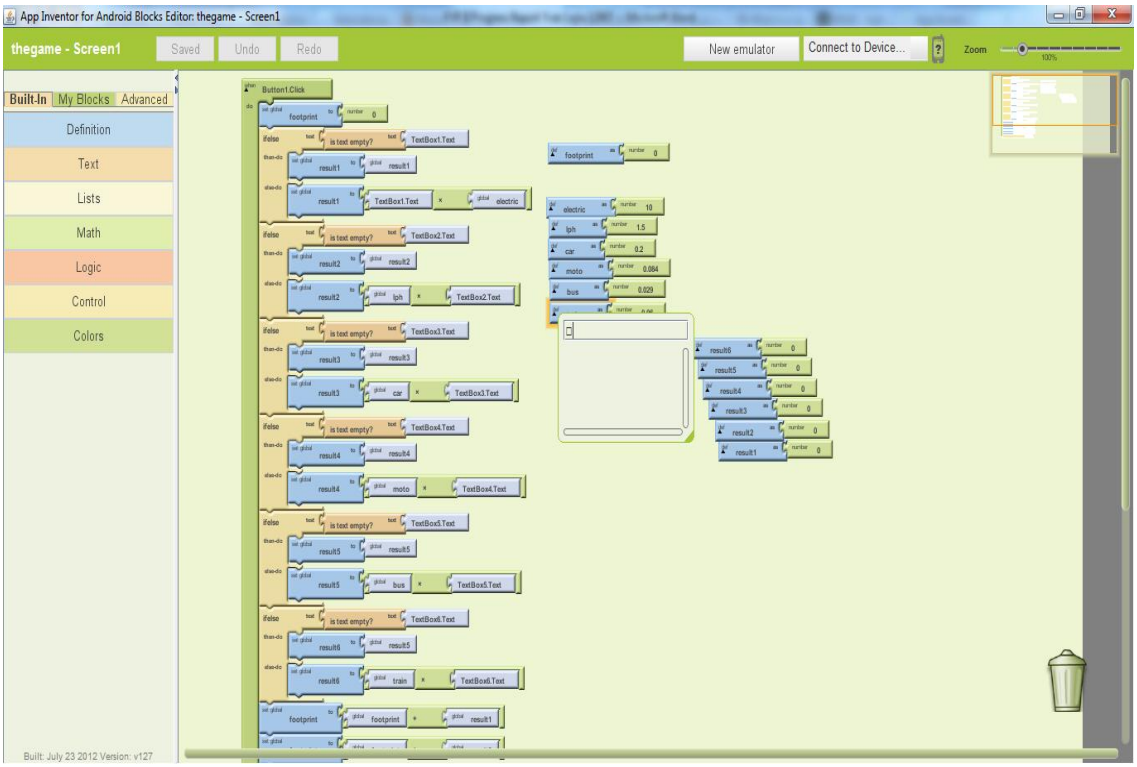

Figure 7: Blocks Editor for MIT App Inventor Beta

The figure above shows the interface where the working logic is implemented within the interface. Logic functions such as loops, if-else statements, and condition checkers can be used to create a working application. The concept of the editor is by using building blocks to implement such functions and events that may take place when the application is running. For instance, a button click will generate a pop up window and etc…

This blocks editor directly works with the elements within the previous interface so that any implementation done within here is applicable to the interface already created.

Testing

- The game will have an in-house testing by selected gamers who have smartphones running on Android OS
- Feedback from gamers will be considered for the game
- The calculator is will be tested personally using one device; a survey will be conducted to measure the impact of the carbon calculator. The target survey group will initially be students.

In accordance to RAD development methodology, design will be developed and then tested and development step will be repeated as many times necessary to iron out bugs or add features which are needed.

3.3 Key Milestones

For FYP II, the key milestones are as depicted below:-

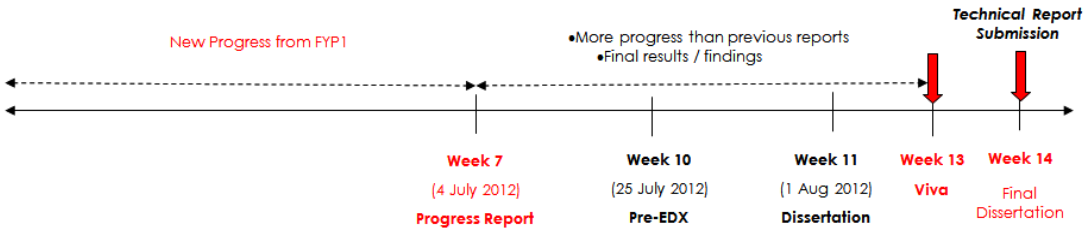

Figure 8: Key Milestones

Source http://elearning.utp.edu.my, Course: Final Year Project II CIS

Milestones:

- Week 7: Submission of Progress Report
  - Progress from FYP I and development report
- Week 10: Pre-EDX Poster Presentation
  - Print poster for presentation
  - Individual poster presentation on project
- Week 11: Submission of Dissertation
  - An almost complete form of a final report on project
- Week 13: Viva
  - Presentation of project (finalized) in front of supervisor and external examiner(s)
- Week 14: Submission of Technical Paper and Final Report
  - Submission of finalized report and the technical paper of the project

Milestones for "FYP II" up to Week 11 have all been met, with the submission of this document.

3.4 Gantt Chart for FYP II – Let's Go Green

No.	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Software Testing and Learning														
2	Development of Calculator														
2	Development of Game														
3	Testing & Survey														
4	Submission of Progress Report														
5	Pre-EDX Poster Presentation														
6	Submission of Dissertation														
7	Viva Presentation														
8	Submission of Final Report														
9	Submission of Technical Paper														

3.5 Tools Required

Hardware

- **Laptop**
  - For development and research; **Dell Inspiron N5110**
  - Laptop specification sufficient for project (internet capability, computing power etc…)
- **Smartphone**
  - For other games testing and game analysis
  - Running on Android OS
  - Using **Samsung Galaxy Note** Running **Android Ice Cream Sandwich (4.0)**
  - Phone specification sufficient for project (Android Market access, computing power and graphics, etc…)

Software

- **Microsoft Word**
  - To produce documentations and milestone deliverables
- **Android SDK (Software Development Kit)**
  - One of the extensions needed to develop software (games) on Android
  - Compiles Eclipse projects into usable Android application
- **AndEngine – Free Android 2D OpenGL Game Engine by Nicolas Gramlich**
  - Engine to develop game designs and game model
  - Library containing the files needed for the game
- **Eclipse IDE for Java Developer**
  - Coding interface; AndEngine will be imported into this system

Chapter 4: Results and Discussion

4.1 Carbon Footprint Formula

Table of Common Consumptions

SI.no	Particulars	Consumption Amount	CO2 emitted to atmosphere
1	Use of Electricity	1 KWhr	10 kg
2	Heating Oil	5 litres	13 kg
3	LPG	2 litres	3 kg
4	Burning of Wood	250 kg	33 kg
5	Car Travel	1000 km	200 kg
6	Motorbike – 125 cc	1000 km	84 kg
7	Motorbike 125 to 500 cc	1000 km	108 kg
8	Bus Travel 1 person	1000 km	1075 kg
9	Train Travel 1person	1000 km	60 kg

Table 1: Table of Common Consumptions

Source: http://toostep.com/question/how-to-calculate-carbon-footprint

Carbon Footprint Finalized Formula

In order to suit Malaysians, which is the target audience/market of my project, the formula obtained had to be modified to be effective in displaying ones carbon dioxide emission. The period of time in calculation is **1 month**.

From the table, the following formula is derived:

Electric Usage (KW/hr) * 10
+ LPH Usage (KG) * 1.5
+ Car Mileage (KM) * 0.2
+ Motorcycle Mileage (KM) * 0.084
+ Bus Usage (KM) * 0.029
+ Train Usage (KM) * 0.06
= Carbon Dioxide Emission in **KG**

Electricity is used by almost every registered household in Malaysia, as well as LPH, for cooking. Transportation has 4 options, whichever is applicable.

Any part of the formula can be omitted if applicable, because in parts like Sabah and Sarawak, buses, trains, and probably motorcycles would be a very difficult to commute with, and only cars would be feasible.

The limitation of this formula is that it is strictly an estimate, and has many assumptions:

- Electricity can be generated through many means, and some do not produce carbon dioxide such as solar power. It is assumed that the electric usage calculated is from the burning of fossil fuels or coal.
- Carbon dioxide emitted through use of LPH can be affected by the burner efficiency, and the materials that are being heated or cooked.
- The rate of carbon dioxide emitted through all the transportation vehicles are also affected by the age of the vehicle, the condition of the engine parts, the type of engine and many more.

To take these factors into account would require more research and resources to accurately find out the actual carbon dioxide emitted. To satisfy the objective of the project, a rough estimate is sufficient to produce the impact wanted.

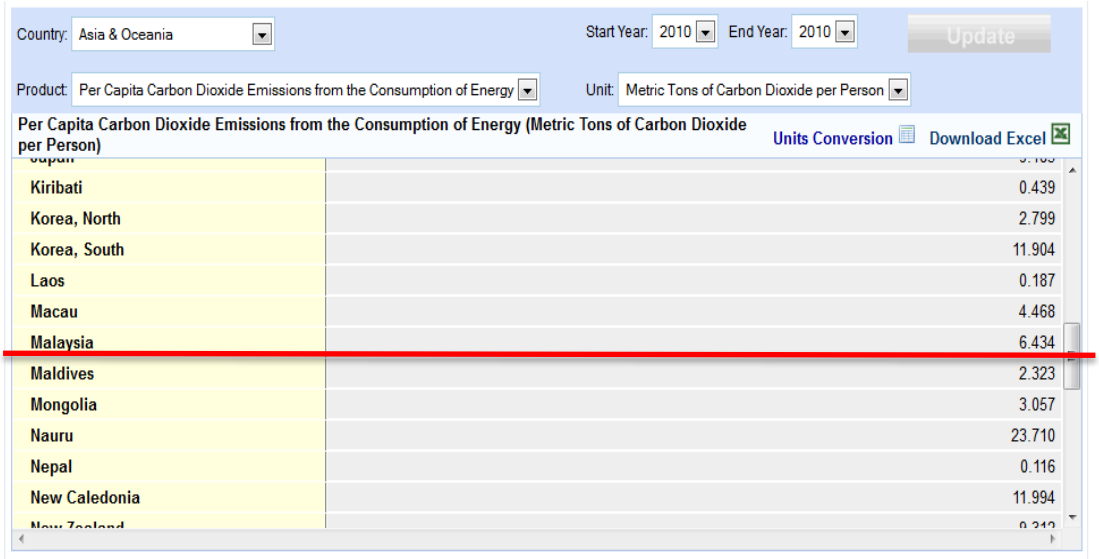

Figure 9: Per Capita Carbon Dioxide Emissions 2010

Source: http://www.eia.gov/

In order to make the results of the carbon footprint calculator more meaningful, a comparison between the average Malaysian and the user of the calculator can be done. From the figure above, the average Malaysian emits 6.434 Metric Tons of carbon dioxide yearly; converted into KG or kilograms would give us 6434 KG of carbon dioxide a year. To compare with a monthly average, 6434 is divided by 12 months: the average Malaysian emitted an estimated 536 KG of carbon dioxide a month in the year 2010. The comparison between the average Malaysian and prospective users of the calculator can produce a more meaningful result which can create a deeper awareness towards global warming, individually.

This statement is included in the carbon calculator application so that users can get a rough idea of how much they affect the environment even through an estimated value.

4.2 Let's Go Green Carbon Calculator

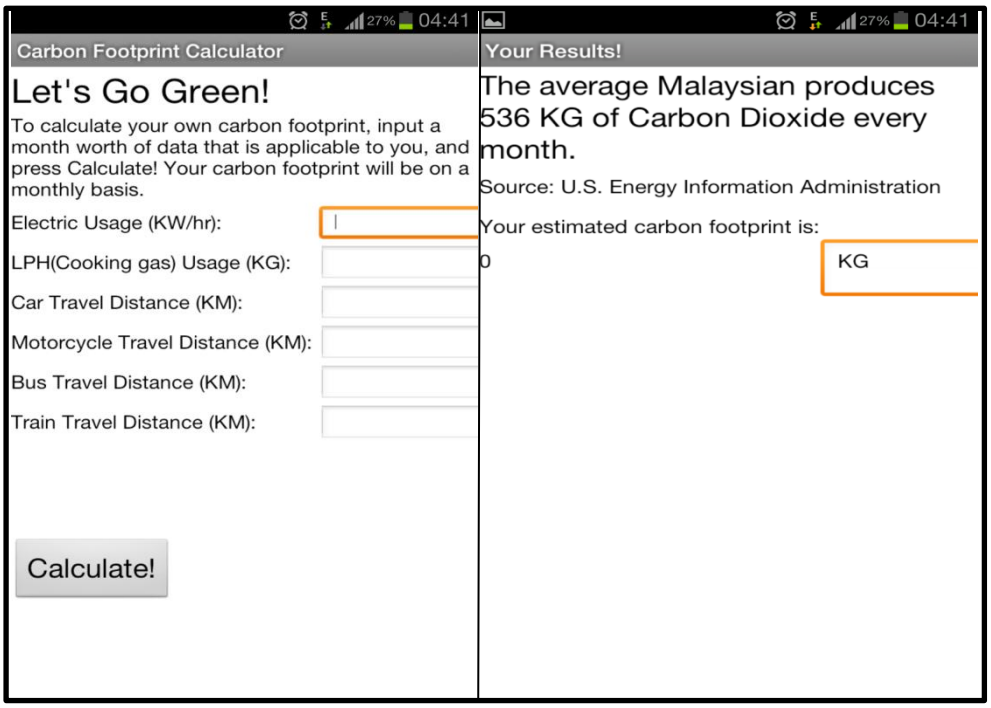

Figure 10: Carbon Calculator Prototype Interface

The figure above shows the two screens on the carbon footprint calculator application. The first screen allows users to input applicable fields; only numbers will be accepted. Any field can be left empty due to differences in mode of transport or whether the user uses electricity to cook instead of LPH.

The second screen (right) will display the user's carbon footprint and the user can see the difference between their carbon footprint and the average Malaysian.

Data Gathering

Using the working prototype of the main core of the project which is the carbon calculator, a survey has been done to test the influence of carbon footprint calculation on the average student.

The number of survey participants is 30, comprising of students in different years of study as well as program.

The survey consists of 5 simple questions with two optional answers; yes or no. The fifth question requires the participant to calculate his/her own monthly carbon footprint using the Let's Go Green carbon calculator.

The survey questions are as follow:

1. Do you know about Global Warming?
2. Do you know what causes Global Warming?
3. Do you take Global Warming as a personal threat?
4. As an individual, do you think that your actions can/may impact the environment?
5. After calculating your estimated carbon dioxide emission (monthly), do you feel more conscious that as an individual, you can affect the environment?

The results of this survey are shown in the table below:

Response	Question 1	Question 2	Question 3	Question 4	Question 5
Yes	**30**	**30**	15	12	**30**
No	0	0	15	**18**	0

Table 2: Survey Results

Data Analysis

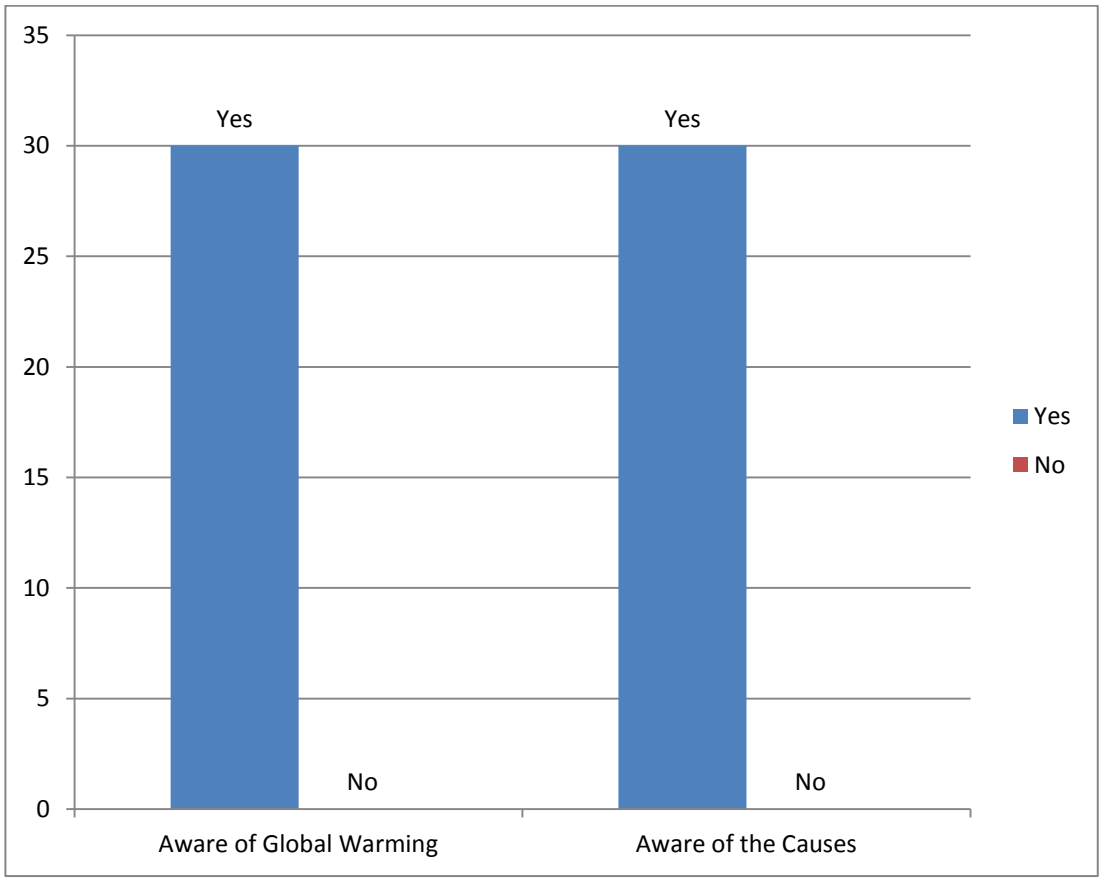

Figure 11: Survey Questions 1 & 2 Bar Chart

From the figure above, the survey has shown that all the participants are well educated on the topic of global warming. They are aware of global warming and they know the causes of the phenomenon. But, this does not show that they are aware of where they stand in the midst of global warming.

The first two questions are aimed at finding out the knowledge level of the participants. This data is unable to show whether or not the participants feel involved in any way towards global warming.

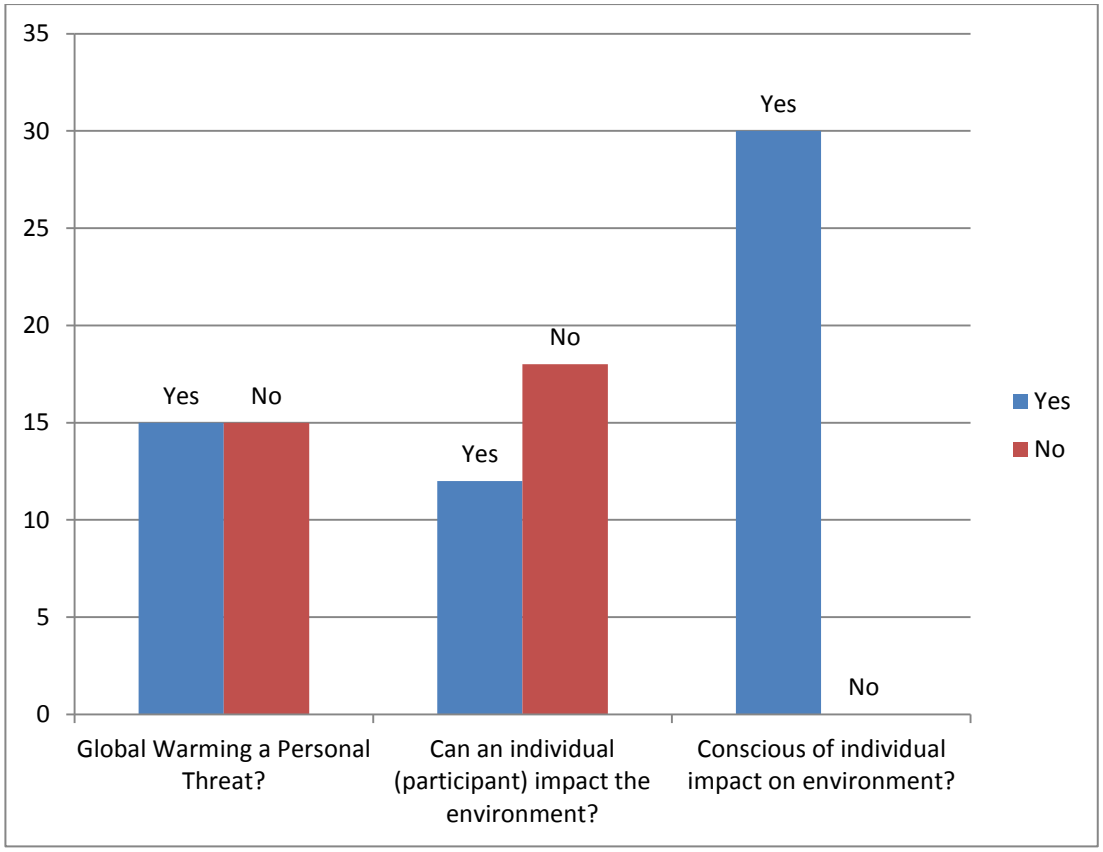

Figure 12: Survey Questions 3, 4 & 5 Bar Chart

From the bar chart, it can be seen that only 50% of the participants feel that global warming can threaten them personally. This may be due to the slow increase of global warming consequences that have yet to threaten the daily lives of Malaysians.

The data also shows that more than half of the participants believe that as a single person, they cannot impact the environment. This may be true for one person out of the estimated 7 billion people on Earth. The idea is that the actions of a single person will not be able to cause a significant effect on the Earth nor contribute to global warming itself.

However, after completing the calculation of their own carbon footprint using the Let's Go Green carbon calculator app, all of the participants are more conscious that as individuals, they can give a significant effect on the environment. If one person continues to emit large numbers of carbon dioxide every month, and everyone thinks the same way, the multiplication of these numbers contributes hugely to the rise of global warming. The collection and analysis of data clearly shows the importance of spreading not just awareness, but the sense of responsibility as inhabitants of Earth.

4.3 Game Design Experimentation

Design 1

Figure 13: Game Design 1 Experimentation

The concept of the game depicted by the above figure is a race car, which has an ozone-layer like shield attached to the front. The car will emit carbon dioxide gas which damages the ozone layer through time. The goal of the game is to maintain the ozone layer as long as possible before it is fully destroyed. The faster the car goes, the faster the score rises. But the faster the car moves, the more carbon dioxide is produced.

Design 2

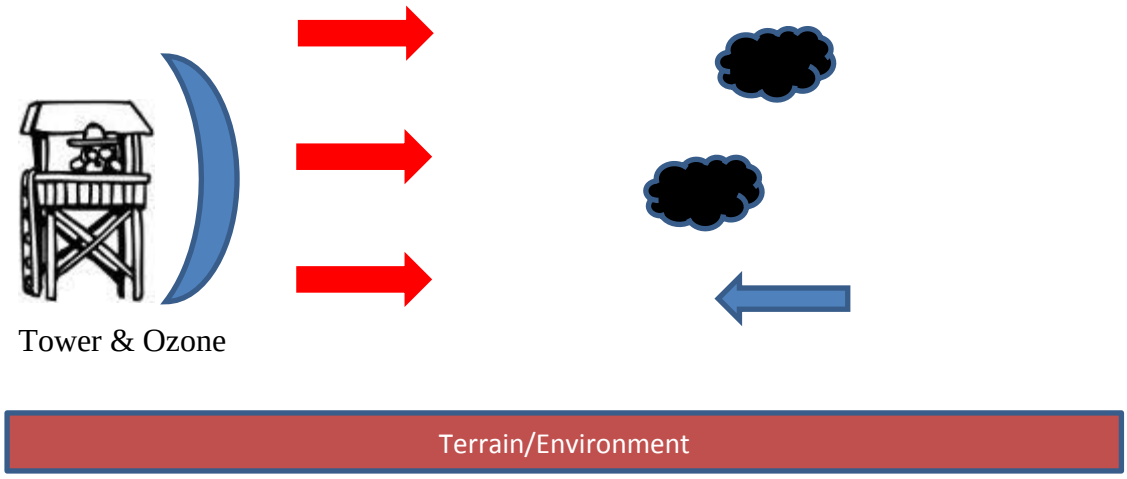

Figure 14: Game Design 2 Experimentation

The above design was a tower defense concept; to protect the ozone layer from harmful gases by destroying the wave of gas molecules. The design was scrapped because it does not show a clear concept of global warming compared to Design 1.

Application Flow Chart

Due to the limited resources and lack of skills, a new flowchart has been developed:

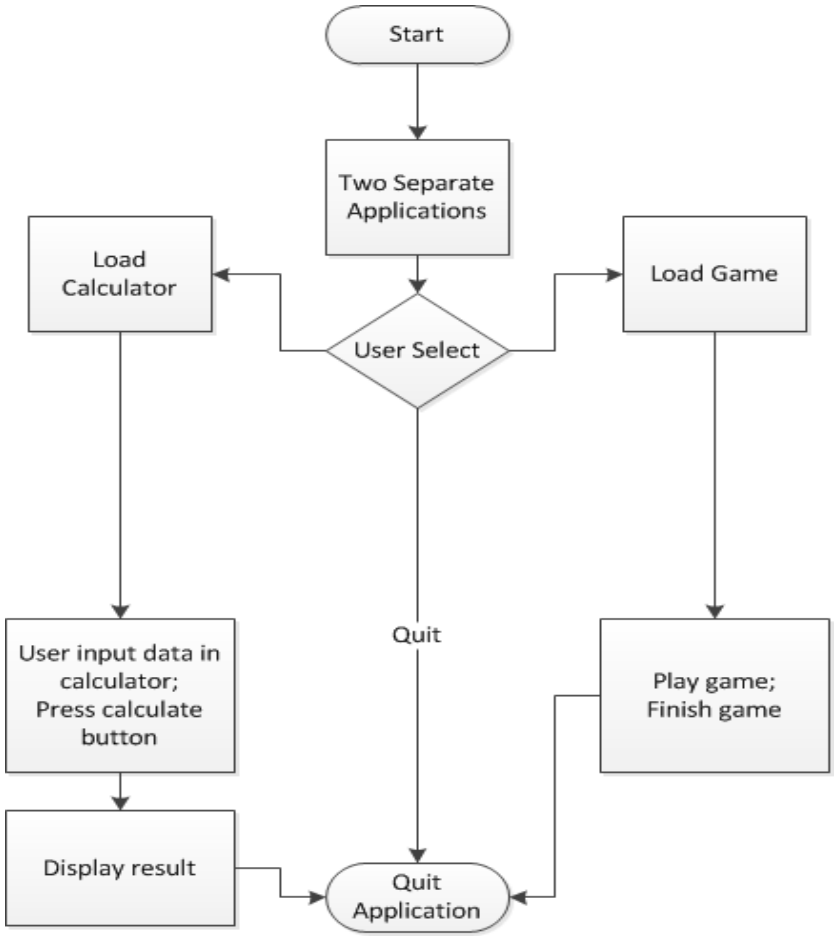

Figure 15: Chosen Application flowchart

The newly developed flowchart shows two separate applications; the calculator and the game. Difficulty in integrating both applications into one will be described in computational difficulties section.

1. User can either use the calculator, or play the game. User will decide which application to launch
2. Usage of either the calculator or the game will be similar to the proposed flowchart, but there will be no menu to return to.
3. The game will be a single level game, further discussed in the game design section.

4.4 Game Prototype

Game development is still in progress, using the examples provided by AndEngine.

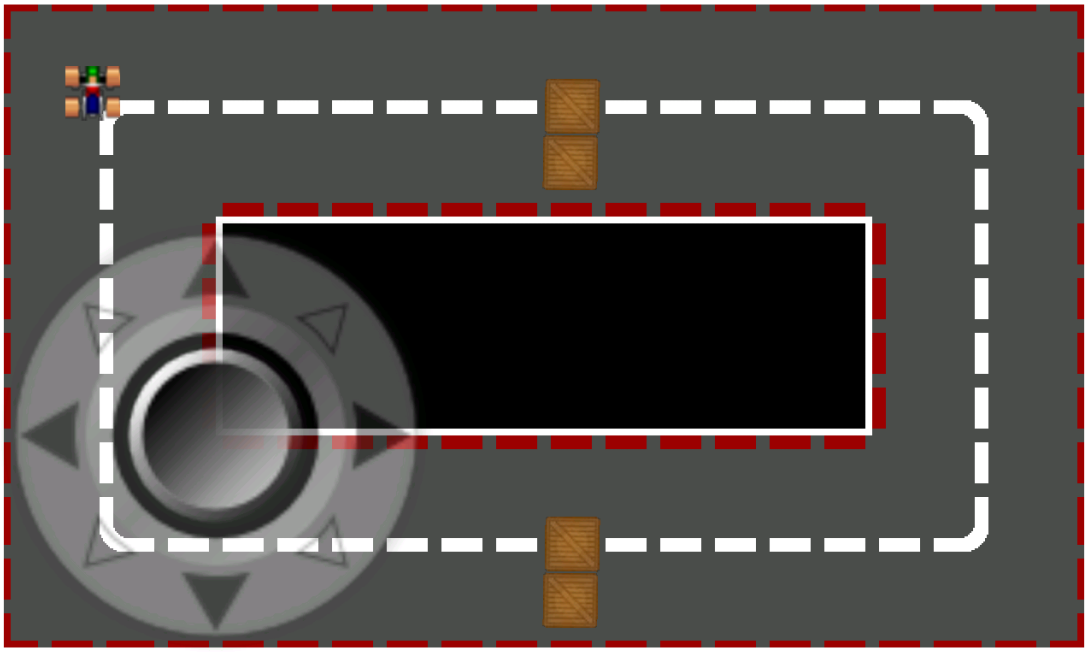

Figure 16: Game Prototype Example

The above figure shows an example of the prototype of the game. As mentioned in the game design experimentation, the above example will incorporate a racecar and a race track. An addition to the game design is a race track type of movement, where the player has to maneuver properly to avoid speeding the car unnecessarily.

The ozone layer and scoreboard is yet to be implemented, due to ironing out the current game bugs and errors.

A control pad is available and the speed of the race car will be based on the intensity of the toggle being moved.

Completed Game

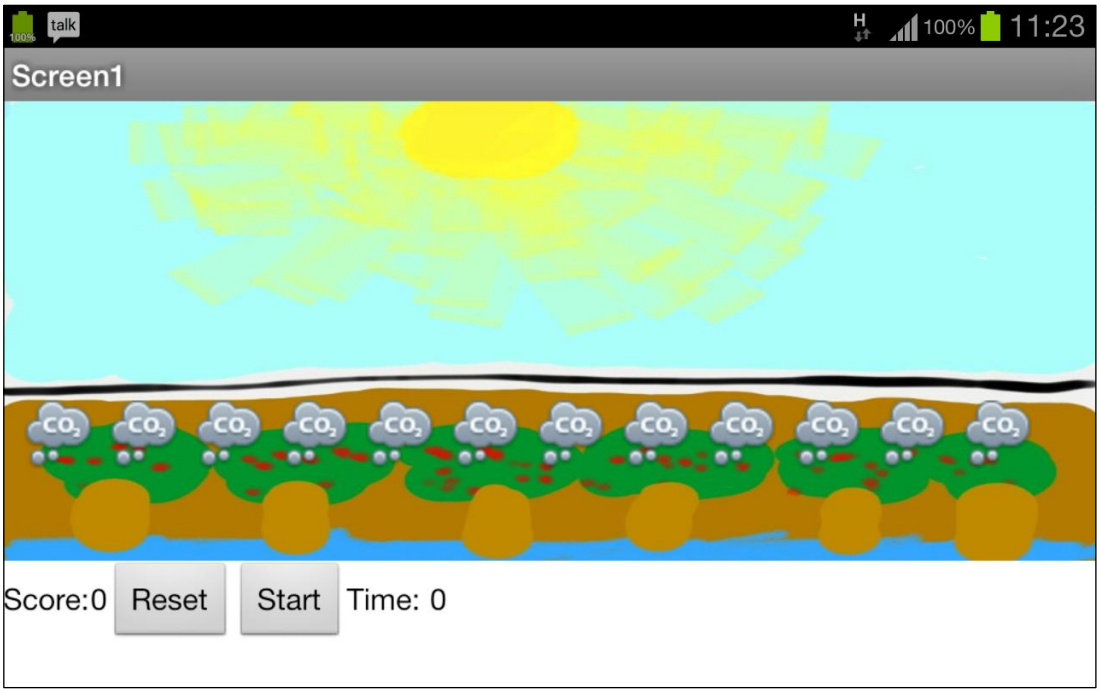

Figure 17: Let's Go Green game screenshot

After testing a few game designs, and through difficulties in developing using different developing tools, the above figure proved to be the most feasible design to implement for the project. The design is simple, where instead of having complex elements for users to understand, the only controls in the game is the tapping of the CO^2 particles. The goal is to keep the particles from reaching the ozone, which is depicted by the top of the screen where the sun is shining. For each successful tap, the particle will disappear but a new particle will come out from the starting position of the tapped particle.

Each tapped particle gives the player 10 points, and there is a time limit of 30 seconds, and the player must try to score the highest score possible. The difficulty of pressing many particles at once expresses the reality of how hard it is to suppress carbon dioxide emissions from the whole world. A higher score can be attained if the particles are tapped very fast. The game does not support multi touch to avoid the game from being too easy. Therefore, the player must coordinate the tapping in order to get a high score.

4.5 Computational Challenges

Software Procurement

There was difficulty in obtaining suitable software e.g. the development tools for the project due to factors:

- Learning Curve
    - Having time limit on the project and lack of knowledge and skills would make it difficult to learn a new programming environment
    - Android application development and game programming are both new environments
    - Chosen tools should be relatively easy to learn and prototypes can be developed quickly
- Price
    - Most interface-based development kits have costs
    - Free trials of the software restricts important features
    - The project money resource is very limited so chosen tools must be free

Game Development

- New Field
    - Lack basics in game development
    - Many new concepts to learn
    - Game engine used is quite new and has lack of documentation to refer to
- Graphics Requirement
    - Artistic graphics need to be used to increase attractiveness of game
    - Lacking artistic talent
- Integration with Calculator
    - Difference in development interface
    - Coding game would require the use of the Engine libraries and the scene management would be complex after embedding the calculator in a single application
    - Having two different applications; a game and a calculator would be much more feasible due to the constraints faced

4.6 Project Deliverables

Documentations:

- Progress Report – Submitted
- Poster – Completed
- Dissertation – Submitted
- Final Report – Completed
- Technical Paper – Completed

Software:

- Game Application file .apk – Completed
- Calculator Application file .apk – Completed

Note: ".apk" refers to the installation package for the software to be installed on Android OS.

Chapter 5: Conclusion and Recommendations

Conclusion

The issues of global warming and greenhouse gas (GHG) emissions have to be addressed, before it gets too severe. Even as individuals, we do have an impact on the environment; driving to school or work contributes to global warming. We may think that if it is us alone, it wouldn't have much damage to the environment, but that's where we are wrong. If the world population does not see global warming as a serious threat, 7 billion people contributing to GHG and carbon dioxide emissions can definitely cause significant impairment to the Earth.

The project targets these individuals in hope that awareness can be spread and based on the carbon footprint calculated, individuals now have a way they can help the environment by trying to reduce their carbon footprint. Early users of the Let's Go Green calculator all have had their eyes opened. The results of their own carbon footprint have shown them that they can destroy the very environment they live in on a monthly basis. Alone we may not matter, but together, we can make a difference.

Future Recommendations

Carbon Calculator

The Let's Go Green carbon footprint calculator is still calculating on estimates. Through more research, a more accurate carbon footprint calculator can be derived that can even cater to the demographic and difference in daily activities to better describe ones impact to the environment.

Further research can also enable individual carbon dioxide emission tracking, thus mapping ones carbon footprint to the daily activities. Individuals can then decide on which activity they want to cut down to improve their carbon footprint results.

A monitoring system can also be added to the calculator to track the performance of an individual's carbon footprint.

Global Warming Concept Game

For now, the project only aims at producing a simple game which applies global warming as a concept. In order to make the game much more attractive and educative, the design can be improved and game developers/designers can be outsourced to produce a much more sophisticated game.

The carbon footprint concept can also be embedded within the game to give the players a more solid feel on how their actions in the game can contribute to global warming.

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http://www.eia.gov/

APPENDIX

"LET'S GO GREEN" MOBILE GAME/APPLICATION FOR GLOBAL WARMING AWARENESS

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Keywords: *Application/game, Android Mobile Platform, carbon footprint, carbon calculator, global warming*

ABSTRACT

The objective of the project is to create an interactive game/application which can create awareness of the carbon footprint and the effect of global warming at an individual level. The game will be used on Android mobile platform due to the popularity of smartphones and tablet devices. There will be two main parts of the project; the game itself and the carbon calculator. The game will serve as an attraction while the carbon calculator will provide create awareness by calculating ones carbon footprint. The problem is global warming and how it is perceived by individuals. Statistical projections show carbon dioxide emissions increasing and global warming is going to get worse. Public awareness on global warming is good but not many take it as a threat. The scope of the study is specific to the Malaysian public. The carbon footprint will be based on primary carbon footprint (energy consumption) for simplicity in calculations. The target group age will vary due to difficulty in predicting whether the game/application will only be used by the smartphone/tablet owner or passed around, e.g. family members using the same device. Rapid Application Development methodology is adopted for the project to quickly produce prototypes which can be tested for results/feedback relevant to improve/correct the game/application. Surveys conducted revealed that individuals only take global warming seriously after realizing their own impact on the environment. The carbon calculator application created awareness successfully on an individual level after tested on a survey group of 30 people.

I. INTRODUCTION

The term carbon footprint generally means the impact of ones activity on the environment, which means the climate change. A carbon footprint relates to the volume of greenhouse gases (GHG) that is produced by a person throughout their daily life. Daily activities such as commuting, using electricity, or even cooking can contribute to the production of GHG. Carbon calculators calculate the carbon footprint of an individual based on a number of inputs such as monthly electricity bills, petrol and gas usage, and so on. Instead of pointing fingers at big corporations and industries which do contribute greatly to climate change and emissions of GHG, carbon footprints provides individuals with the impact of their daily lives on the environment, so that actions can be taken on an individual level. The combination of a game and the carbon calculator is a different approach to merely just calculating ones footprint. The challenge would be to attract potential players with an attractive game, and then creating a way to communicate the effect of the calculated carbon footprint and what can be done to reduce it.

A. Problem Statement

Global warming is caused by emissions of greenhouse gases (GHG) which trap heat within the Earth's atmosphere, and carbon dioxide erodes the ozone layer, allowing the sun's harmful rays to penetrate heat the Earth further. The main problem is not just the lack of awareness, but not knowing who is responsible and what can be done to help

remedy this issue. According to an article, "Top-Emitting Countries Differ on Climate Change Threat", by Anita Pugliese and Julie Ray dated 2009; although aware of global warming, one third of the population of countries aside from Japan do not see this as a serious problem, although being the top emitters of GHG. It can be deduced that although people are aware of this happening, but they still do not see the connection of their actions and global warming itself.

B. Objective

The objectives of this project are as outlined below.

1. To create an interesting educative game/application which can raise awareness on global warming at an individual level
2. To provide a means to measure one's carbon footprint which can be used to reduce ones carbon emission

C. Scope of Study

The scope of this study will cover the feasibility of using mobile games as an educative learning tool, and the availability of the tools/information needed on developing a carbon calculator application. The calculator will be specific to Malaysians.

Android development will also be included in scope of study, which encompasses game development, Android compatibility, and attractive game design based on market trend.

II. LITERATURE REVIEW

A. "WORLD CARBON DIOXIDE EMISSIONS: 1950–2050" by Richard Schmalensee, Thomas M. Stoker, and Ruth A. Judson

The paper above describes the projection of carbon dioxide, a greenhouse gas which damages the ozone layer and traps heat within the Earth's atmosphere, in years 1950 to 2050. The authors used economic statistical methods to compute graphs which find the connection between the countries' Gross Domestic Product (GDP) and how much carbon dioxide that country emitted. Based on the graphs, the higher the GDP, the more carbon dioxide produced by that country. The paper also aims to challenge the Intergovernmental Panel on Climate Change (IPCC) on its projection of carbon dioxide emissions from 1950-2050 which was calculated based on historic benchmarks. From their calculations (using the same data from IPCC) the newly derived graph depicts a significant difference which shows that more carbon dioxide will be emitted compared to the one from IPCC.

B. "Educational Video Game Design: A Review of the Literature" by Mary Jo Dondlinger

The article studies whether or not the games can be beneficial for learning, and the theories of learning that can explain why games can foster learning. It focuses on the design of the game, how the game educates its player instead of what players learn from games. The review discusses elements of effective video game design, which includes motivation, narrative context, goals & rules, interactivity and multisensory cues. Analysis of previous literature proves the significances of these elements towards an effective game design, and makes a game interesting or not in the eyes of the player. The theories of learning that are studied include constructivism, constructionism, and situated cognition; these theories are for video games, and how players can learn from video games. Research cited in the article suggest that learning outcomes from games include modern skills, deduction, hypothesis testing, complex concepts, visual and spatial processing.

C. Carbon Footprint Website: "carbonfootprint.com"

There are two categories of carbon foot prints, primary which directly involve the person (e.g. car usage) and secondary which indirectly involves the person (e.g. manufactured products purchased).

III. METHODOLOGY

A. Software Process Model

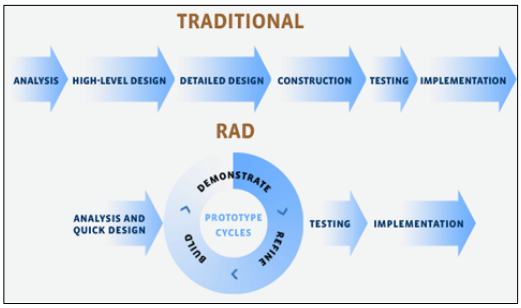

Figure 1: Rapid Application Design (RAD) Model

RAD is a result-based methodology, developed to respond to the need to deliver systems very fast. The RAD approach might not be applicable to all projects – much research would be needed for a traffic control system and RAD would be inappropriate. A projects scope, size and circumstances would determine the effectiveness of using a RAD approach. This project scope is

specific; a game and a carbon calculator. Deadline for the project is within 8-9 months, in which the project will be worked on part-time. Most probably project work will occur at random hours of the day every week and also whenever possible (free time). The goal of the course is to produce a working prototype with an impact, therefore RAD is most appropriate.

This project phases will be divided to:

- Project Analysis and Requirements Gathering
- Project Design
- Project Development
  - Implementation & Testing
- Project Deployment

B. System Architecture

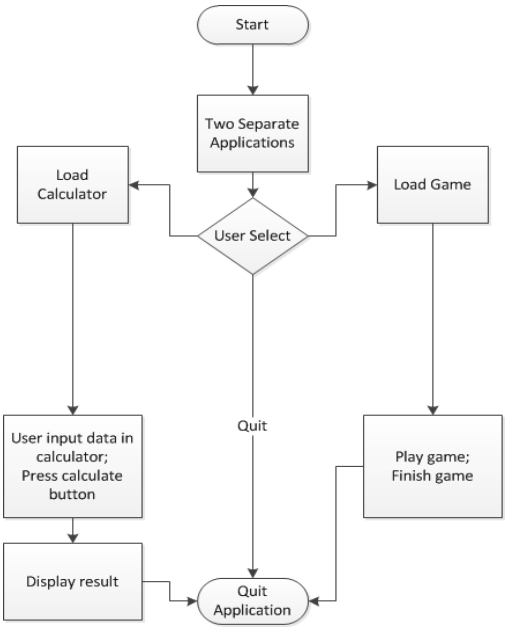

Figure 2: System Flowchart

The flowchart shows two separate applications; the calculator and the game.

1. User can either use the calculator, or play the game. User will decide which application to launch

2. Usage of either the calculator or the game will be similar to the proposed flowchart, but there will be no menu to return to.

3. The game will be a single level game, further discussed in the game design section.

C. Tools Required

Hardware

- Laptop
- Smartphone

Software

- Microsoft Word
- Android SDK (Software Development Kit)
- Eclipse IDE for Java Developer
- MIT App Inventor

IV. RESULTS AND DISCUSSION

There are three main parts of the findings, firstly the carbon footprint formula, second the results of carbon footprint application survey, and third, game design.

A. Carbon footprint formula

Procured carbon footprint formula to be used in carbon calculator app:

Electric Usage (KW/hr) * 10

+ LPH Usage (KG) * 1.5

+ Car Mileage (KM) * 0.2

+ Motorcycle Mileage (KM) * 0.084

+ Bus Usage (KM) * 0.029

+ Train Usage (KM) * 0.06

= Carbon Dioxide Emission in **KG**

In order to make the results of the carbon footprint calculator more meaningful, a comparison between the average Malaysian and the user of the calculator can be done. The average Malaysian emitted an estimated 536 KG of carbon dioxide a month in the year 2010 (http://www.eia.gov/). The comparison between the average Malaysian and prospective users of the calculator can produce a more meaningful result which can create a deeper awareness towards global warming.

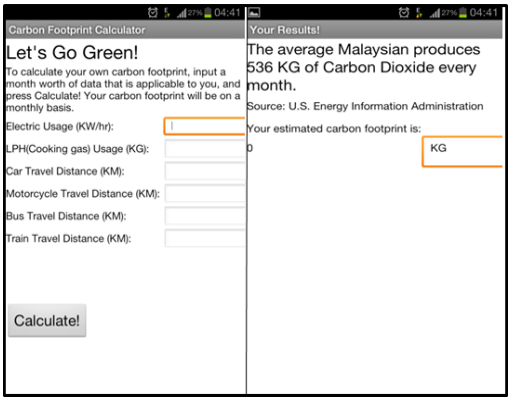

Figure 3: Carbon Calculator App Screenshot

The figure above shows the two screens on the carbon footprint calculator application. The first screen allows users to input applicable fields; only numbers will be accepted. Any field can be left empty due to differences in mode of transport or whether the user uses electricity to cook instead of LPH.

The second screen (right) will display the user's carbon footprint and the user can see the difference between their carbon footprint and the average Malaysian.

B. Results of carbon footprint survey

Using the working prototype of the main core of the project which is the carbon calculator, a survey has been done to test the influence of carbon footprint calculation on the average student.

The number of survey participants is 30, comprising of students in different years of study as well as program.

The survey consists of 5 simple questions with two optional answers; yes or no. The fifth question requires the participant to calculate his/her own monthly carbon footprint using the Let's Go Green carbon calculator. The survey questions are as follow:

1. Do you know about Global Warming?
2. Do you know what causes Global Warming?
3. Do you take Global Warming as a personal threat?
4. As an individual, do you think that your actions can/may impact the environment?
5. After calculating your estimated carbon dioxide emission (monthly), do you feel more conscious that as an individual, you can affect the environment?

The results of this survey are shown in the table below:

Answer	Q1	Q2	Q3	Q4	Q5
Yes	**30**	**30**	15	12	**30**
No	0	0	15	**18**	0

Figure 4: Survey results

The survey results show that all the participants are well educated on the topic of global warming. They are aware of global warming and they know the causes of the phenomenon. it can be seen that only 50% of the participants feel that global warming can threaten them personally. This may be due to the slow increase of global warming consequences that have yet to threaten the daily lives of Malaysians.

The data also shows that more than half of the participants believe that as a single person, they cannot impact the environment. This may be true for one person out of the estimated 7 billion people on Earth. The idea is that the actions of a single person will not be able to cause a significant effect on the Earth nor contribute to global warming itself.

However, after completing the calculation of their own carbon footprint using the Let's Go Green carbon calculator app, all of the participants are more conscious that as individuals, they can give a significant effect on the environment. If one person continues to emit large numbers of carbon dioxide every month, and everyone thinks the same way, the multiplication of these numbers contributes hugely to the rise of global warming. The collection and analysis of data clearly shows the importance of spreading not just awareness, but the sense of responsibility.

C. Game Design

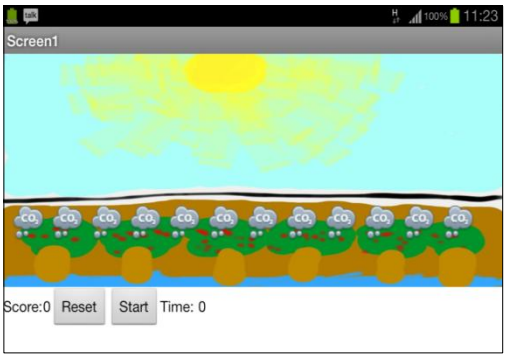

Figure 5: Let's Go Green game screenshot

After testing a few game designs, and through difficulties in developing using different developing tools, the above figure proved to be the most feasible design to implement for the project. The design is simple, where instead of having complex elements for users to understand, the only controls in the game is the tapping of the CO^2 particles. The goal is to keep the particles from reaching the ozone, which is depicted by the top of the screen where the sun is shining. For each successful tap, the particle will disappear but a new

particle will come out from the starting position of the tapped particle.

Each tapped particle gives the player 10 points, and there is a time limit of 30 seconds, and the player must try to score the highest score possible. The difficulty of pressing many particles at once expresses the reality of how hard it is to suppress carbon dioxide emissions from the whole world. A higher score can be attained if the particles are tapped very fast. The game does not support multi touch to avoid the game from being too easy. Therefore, the player must coordinate the tapping in order to get a high score.

V. CONCLUSION

The project targets individuals in hope that awareness can be spread and based on the carbon footprint calculated, individuals now have a way they can help the environment by trying to reduce their carbon footprint. Early users of the Let's Go Green calculator all have had their eyes opened. The results of their own carbon footprint have shown them that they can destroy the very environment they live in on a monthly basis.

Through more research, a more accurate carbon footprint calculator can be derived that can even cater to the demographic and difference in daily activities to better describe ones impact to the environment. The game design can be improved and game developers/designers can be outsourced to produce a much more sophisticated game. The carbon footprint concept can also be embedded within the game to give the players a more solid feel on how their actions in the game can contribute to global warming.

VI. ACKNOWLEDGEMENT

First of all, the writer expresses his deepest gratitude and appreciation towards the project supervisor, Prof. Dr. Alan Oxley, who has supported and guided the activities throughout the project. The comments, advices, insights received have been a major help to completing this project and crucial for achieving success in the project objectives. The writer also extends his gratitude and appreciation towards the university, Universiti Teknologi PETRONAS and the Computer Information Sciences department for the knowledge and skills passed down throughout the writer's years of study. Not forgetting the Final Year Project coordinators for efficiently coordinating the project and guiding the project deadlines flawlessly. Lastly, the writer would also like to thank the participants of the survey as well as those directly/indirectly involved in the project.

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