

Just Hot Air?: Teaching about the Greenhouse Effect

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Abstract

The Australian Cooperative Research Centre for Renewable Energy (ACRE) was established by the Commonwealth Government to promote renewable energy and greenhouse gas abatement technologies. As well as research and development programs aimed at realising their widespread implementation ACRE sees itself as having an important role in the communication of information about these technologies to the public and school students. This paper looks at the "Just Hot Air?" program of activities which has been developed and trialed by the School and Community Education project within ACRE to help teachers teach, and students learn, about the Greenhouse Effect.

1 INTRODUCTION

The Greenhouse Effect is one of those subjects which children find difficult to grasp. Studies by Boyes et al. (1993) and Rye et al (1997) have shown that students in the upper primary and lower secondary age groups readily confuse the causes and consequences of the enhanced greenhouse effect with the thinning of the ozone layer and ultraviolet radiation. Similarly the effect is often dismissed simply because 'it doesn't feel like it's getting hotter'.

2 JUST HOT AIR?

The *Just Hot Air?* program developed by ACRE's School Education Project works through the broad subject area of global warming progressing through three stages of; What is the Greenhouse Effect?; How much Greenhouse Gas do I produce?; What can I do to reduce my Greenhouse Gas emissions? Although these stages can be used as three separate lessons, they have been successfully integrated into a single one to one and a half hour workshop style lesson. This integrated format was used at the "Kids Helping Kids Conference" held in Perth in early October 1997 and at professional development workshops for Western Australian high school science teachers.

2.1 What is the Greenhouse Effect?

This stage of the program includes a number of activities designed to increase the participants knowledge of the Greenhouse Effect, how we know the Earth is getting warmer, and some of the changes that we can expect to observe. When introducing this stage, a modified version of the 'Frog in the Frypan' story is related to the students, highlighting the importance of helping to find solutions to environmental problems when we first notice them. The story is of unknown origin, but was first relayed to the author by Dr Peter Dingle, a prominent environmental communicator in Perth.

The 'Frog in the Frypan' is a tale all about the cooking of frogs and it presents an interesting analogy to the slow increase in global temperature as a result of global warming, and addresses one of the main sources of confusion regarding the Greenhouse Effect, that it doesn't feel like its getting warmer. Just because you can't feel it, doesn't mean that it isn't happening! Props such as a toy frog and frypan often aid the telling of the story which goes something like this:

How many of you have heard of a French delicacy known as "cuisses de grenouilles", or Frogs Legs? Well, when you are trying to cook frogs, you can't place them straight into a hot frying pan because they immediately jump out because its too hot, just like when you dip your toe into the bath to test how hot it is and pull it out because its too hot. So when you cook them, you have to put them into a cold frying pan and warm it gently. The frog likes the warmth and it starts to settle down as the frying pan is slowly getting warmer. Unfortunately the frog doesn't realise that it's being cooked until its too late!

The story works particularly well with the lower secondary age group, who are amused by the fact that the humble frog is considered a delicacy in some parts of the world, and fascinated by the thought of cooking such a creature!

In the workshop format, after the introduction, this stage breaks into two groups of activities; "Modelling" and "Analysing".

2.1.1 Modelling

This group of activities include three main activities; The Greenhouse Effect; Sea level Change - Melting Icebergs; Sea Level Change - Melting Sheet Ice. As these activities model long term changes, the activities are set up at the beginning of the stage and continue until the completion of the workshop. In the case of the Greenhouse Effect model, the temperature of the air enclosed inside three different PET plastic bottles is recorded every ten minutes. The two Sea Level Change activities involve observing and recording the height of the water level every ten minutes and noting the amount of ice remaining in the containers.

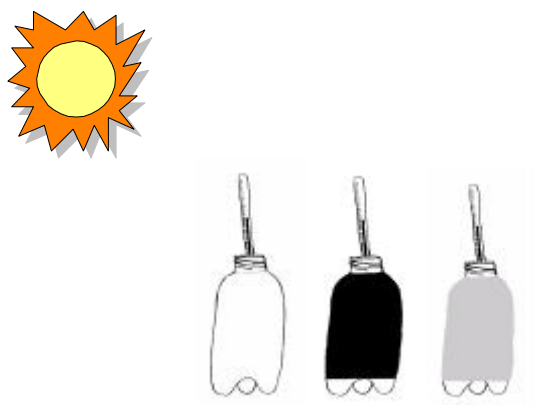


Figure 1. Three PET bottles are exposed to direct sunlight to model the Greenhouse Effect.

As can be seen in Figure 1, three PET plastic bottles are used as the basis for the Greenhouse Effect model. One bottle is covered with a dark material, the second with aluminium foil and the third is clear. The bottles have thermometers which are situated so that the bulb sits about half way down the height of the bottle, and they are then placed so that they can collect and store solar energy inside the containers. The temperatures of each of the bottles is recorded every ten minutes through out the entire duration of the workshop.

The Sea Level Change activities, Melting Sea Ice and Melting Sheet Ice, shown schematically in Figures 2a and 2b, consist of two containers of water which are placed side by side where they can collect sunlight. In the Melting Sea Ice activity, (Figure 2a), cubes of ice are placed into the container so that the top of the meniscus of the water is level with the edge of the container. At ten minute intervals throughout the entire duration of the workshop the water level is checked and the amount of ice remaining is also noted.

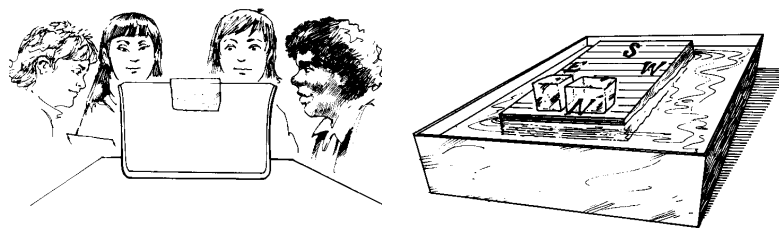


Figure 2 Set up for the a) Melting Sea Ice and b) Melting Sheet Ice activities respectively (reproduced from Morris et al, 1990).

The Melting Sheet Ice activity, (Figure 2b), which consists of a similarly sized container of water with a piece of wood (10 cm x 10 cm x 2 cm) floating in it with ice cubes sitting on top of the wood. Using a compass, the wood is marked with the N, S, E and W directions. In the East-West direction, lines are scored in the wood at 2 cm intervals, in the North-South direction, the scorings are 2 mm apart. Several blocks of ice are placed along the Northern edge. At ten minute intervals throughout the entire duration of the workshop the water level on the North and South edges of the block are checked and the amount of ice remaining is also noted.

2.1.1 Analysing

Once the experiments are set up, the participants are involved in analysing and graphing atmospheric carbon dioxide and temperature data from the Vostok Ice Core data available on the internet through the Lamont-Doherty Earth Observatory (LDEO) Climate Group at Columbia University. This website can be found at <http://rainbow.ldeo.columbia.edu/ees/climate/labs/vostok/>. In this activity, the students are presented with data in tabulated format of the atmospheric carbon dioxide concentration and temperature data as recorded in the Vostok Ice Core samples from Antarctica. The students are asked to plot and discuss the changes as a function of time.

The students are introduced to the concept of working scientifically and acquire skills in the analysis and graphic presentation of data as well as achieving cognitive objectives such as the realisation that average global temperatures are relatively stable and that changes of only a few degrees as a result of increased carbon dioxide concentrations in the atmosphere can have dramatic consequences on the world's climate. During the activity, students also gain a greater confidence in reading and analysing data sets.

There are almost endless possibilities for the type of activities that can be used in the Analysing component of the program and these can be exchanged for suitable activities to tailor the program to the specific curriculum. Teachers who have taken part in the Professional Development version of the *Just Hot Air?* program receive a Resource Kit to supplement the program, which includes a number of alternate activities suitable for use in the program. Activities on Ozone and CFC's have been deliberately excluded from this program as these topics have been identified as areas which cause confusion amongst students in other Greenhouse Education Programs (Rye, 1997).

2.2 How much Greenhouse Gas do I produce?

This stage uses the Australian Home Greenhouse Scorecard computer program and the accompanying questionnaire to conduct a mini audit of the participant's greenhouse emissions at home. The questionnaire consists of 53 questions which correspond to the questions asked in the Australian home Greenhouse Scorecard software, and usually takes about 10 to 15 minutes for the participants to complete. After the completion of the questionnaire, students input their results into the computer program and obtain a print out of their audit results. Figure 4 shows a participant at the Kids Helping Kids conference entering her questionnaire results into the Australian Greenhouse Home Scorecard on a laptop (PC) computer.



Figure 4. A female participant at the Kids Helping Kids conference using the laptop computer to enter her questionnaire data into the Australian Home Greenhouse Scorecard.

The Australian Home Greenhouse Scorecard, developed by Sustainable Solutions Pty Ltd under contract to the Environmental Protection Agency (Victoria), uses a cleverly designed graphical interface to input the questionnaire results into the package. The program window (Figure 5) features a cutaway house which acts as a clickable map with icons that correspond to the subject headings in the questionnaire. On the right hand side of the program window, a running tally of the greenhouse emissions for the household is displayed.



Figure 5. The Program Window from the Australian Home Greenhouse Scorecard.

After entering all of the data into the program, a report can be displayed which shows a pie chart of the percentage of total emission for each of the areas and compares the users greenhouse emissions to the average house and that of a 'green' home. A typical example of this screen is shown in Figure 6

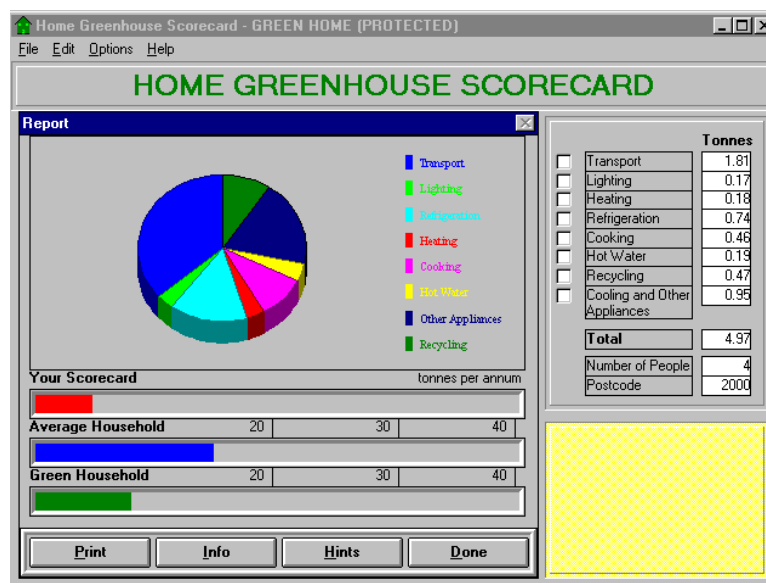


Figure 6. A typical screen in the results section of the Australian Home Greenhouse Scorecard.

In this window, a hints button appears which identifies areas where the user may be able to reduce their emissions. The hints window also features clickable options which allows the user to see what their emissions are with the adoption of some or all of the hints. When there are limited computing facilities available, participants finish this stage after they have obtained a print out of their results.

2.3 What can I do to reduce my Greenhouse Gas emissions?

Following on from the last section of the previous stage the participants are encouraged to draw up their own personal Greenhouse Gas Reduction Strategies.

To demonstrate the effect of minor changes around the home, the participants complete an activity about Compact Fluorescent Lights (CFL), where they graph the cost of electricity versus time over the lifetime of a CFL, typically 8000 hours (Office of Energy, 1997). Although the cost saving is only about ten dollars per year, this equates to a reduction in emissions of around 480 kg of carbon dioxide, or an 80% reduction in emissions from lighting over the entire lifetime of the CFL!

We have found that this activity encourages the participants to find other areas where they could easily reduce emissions without compromising their standard of living. Individual reduction strategies of participants are often similar in nature, ie 'walk to school instead of getting mum to drive me', 'use cold water in the washing machine', CFLs' and 'turn off lights when I leave the room' and discussion of strategies often simultaneously erupt amongst the students. This activity also elucidates strong responses from participants with regard to Australia's policy on Greenhouse Emissions as the Kyoto Summit draws closer.

3 SUMMARY

ACRE has successfully developed a program *Just Hot Air?* aimed at teaching upper primary and lower secondary school students about the Greenhouse Effect. Although the *Just Hot Air?* program is still being trialed, preliminary results suggest that the program is successful in raising the awareness of Greenhouse Gas issues amongst school students.

4 ACKNOWLEDGMENTS

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