Global Warming as a result of Land Misuse

Joseph J. McGuire
Oliver High School

Overview

This curriculum unit will focus on the problem of global warming because of anthropogenic causes. This unit will examine the underlying science of global warming as well as strategies that society can implement to slow the progression of this phenomenon. The students targeted for this unit will include grades nine through twelve. This unit is intended for mainstream and scholars Biology classes. The unit requires students to think critically and to write about their experiences and thoughts in a journal format. The unit will allow students to visualize the scientific process included in the study of global warming and apply these processes to an experiment of their own.

Rationale

Within the past few years, there has been growing movement toward the adoption of inquiry-based teaching techniques. This movement was sparked by the completion of the TIMSS study. The TIMSS study includes data from countries all around the world. It has been found that students tend to grasp subject matter with greater ease when taught using inquiry-based techniques. As an attempt to stay current with contemporary educational practices, the Pittsburgh Board of Education has adopted an inquiry-based text for the district's Biology program. Students are now required to take benchmark examinations that align with the PSSA testing. Biology courses are now required to teach a unit on the human beings environmental impact on the Earth. The subject of Global Warming is not only relevant to today's understanding of climate change, but also lends itself to a hand on approach to instruction.

Students include a wide range of learners from ninth to twelfth grade. This curriculum unit will be taught to mainstream students as well as Scholars students. The district's Biology text, Biology a Human Approach, attempts to draw students' imagination into the subject through discovery and open-ended questions. The current text does not include a section that deals with global warming and the health of our planet due to deforestation. The concept of global warming lends itself to the biology curriculum while recognizing weather patterns and mathematics that exist within the natural world. I hope that this curriculum unit will get students started into thinking about this important area of science. I also hope this unit will give students an understanding of how different disciplines of science can intermingle. This curriculum unit will enable the teacher to incorporate mathematics that satisfies the standards and math anchors that the district strives to meet within the science curriculum.

Students will gain an insight on the greenhouse gases that are being pinpointed by the IPCC. Students often have the misconception that the gases being discussed are chemically complex. In reality, the gases that are being recognized are as simple as water vapor and carbon dioxide. Students then tend to understand the problem when they realize they are familiar with the gases involved. Students will also recognize that the information has already been introduced to them at some time and in some way in their education. The introduction of the greenhouse gases will give students the knowledge to visualize how these gases cause global warming. Students will be able to recognize that bond angles are important to the global warming discussion. Knowledge of greenhouse gases will also allow students to realize the connection between deforestation, reforestation, photosynthesis, and cellular respiration. The fact that deforestation can be directly linked to the loss of carbon sequestration will become evident.

This unit will dovetail into the current curriculum. The unit will be designed to fit into the environmental section of the curriculum. This unit will also revisit with the subject of energy exchange through systems. More specifically the areas of photosynthesis and cellular respiration will be incorporated into the curriculum unit. The visualization of the processes involved will give students real understanding of the problem of global warming. Students will be given a model to build that will simulate global warming. Students will be able to collect data from the model and make conclusions based on the data. Students will keep a journal that will be evaluated for accuracy and completeness.

This unit will allow students the chance to explore the idea of computer-simulated modeling when it comes to predictions in climatic systems. Students will be able to gain knowledge on the complexity of such modeling. Students will

also be able to understand the effects of negative and positive feedback systems that take place within the environment. The understanding of negative and positive feedback systems will be covered extensively. Students often do not understand what makes a feedback system positive or negative. The concept of feedback systems is crucial in the experimental process and this will be used to reinforce experimental design that was covered at the beginning of the year. All of these factors will help students understand how the scientific method is used to solve problems within various disciplines of science. Computer modeling will also be used in the unit in order to introduce students to the process of smoothing over a system to demonstrate a phenomenon in the simplest terms. It is important that students realize that computer modeling is complex but within reach of today's scientist. Once again, it is also a chance for students to see how different scientists use different approaches to arrive at the same answers as well as different answers. Computer modeling also gives the student a chance to decide based on reasoning the method that they will accept

I hope that this unit will make students aware of the current problems we as a planet are facing. The presence of global warming not only threatens our quality of life, but the lives of our grandchildren and their future generations. It is important for students as well as adults to realize that all advances in science and technology do not always bring about positive change as we are seeing with the results of the Industrial Revolution. The inclusion of ethics will also be included in this unit. Students will get a chance to write about global warming. The writing will be a persuasive essay on a topic that deals with global warming. The essay will then be read to the class and critiqued. The problem of climate change is more complex than any other problem seen by modern civilization. The solution does not only include big business but each individual as well. Change needs to happen to slow the progression of global warming. Change may include new fuel sources, alternative transportation methods, and the implementation of new agricultural technology. These changes will not mean a thing until future generations realize the true threat we are facing. Change begins with education and continues through practice and implementation of our knowledge. Many say that global warming is not a result of human interaction with the environment. There are those who contend that climate change is a cyclic event. Even if climate change is a cyclic event what are the chances we as a civilization will be able to reverse it. Even if climate change is a cyclic event what is wrong with wanting cleaner air and water if not for our own health and well-being. The time for current generations to look toward the future beyond our lives is now. Responsibility for the mistakes of past generations must be taken; these mistakes will not correct themselves. It is important to realize that change may bring about a slowdown of global warming, but it will not come without a price. That price should not influence our attempts to remedy this problem. Students will gain insight on creating a debate. Students will get a chance to construct an argument

in addition to their persuasive essay, by doing research and interacting with their fellow classmates. Students will then put their work to the test. This exercise allows students to fulfill portfolio requirements in writing.

I plan to give students a history of global warming so they might understand the reasoning that goes into the science that is being presented. It is important that students see other points of view when it comes to solving scientific problems. Various approaches are often what it takes for a solution to be viable. Thinking out of the box is an important skill for students to learn. Building on scientific findings of others has been and will remain a mainstay in the scientific community. The history of global warming will give students a chance to see the progression of scientific concepts. Students will begin to realize why every part of the puzzle is important when it comes to solving difficult problems such as global warming. The history of global warming will also allow students a chance to see how science is often, over shadowed by politics and public opinion. The realization that culture determines what is accepted as far as scientific belief is a sobering fact. Students will begin to realize even if a point of view is not popular as long as it is backed by scientific data it may be valid and worth exploring.

Students will model the layers of the atmosphere in order to gain an understanding of the dynamic that exists within it. Students will also get to model global warming on a small scale in order to see how a system reacts. Students tend to gain knowledge and retain it better by hands on inquiry activities. Students will then be able to relate the atmosphere and the temperature fluctuations with deforestation and the destruction of natural carbon sinks.

Students will discuss current issues concerning deforestation and brainstorm possible remedies to this real and present problem. I hope that students will realize how the environment works together as a whole and how disturbing one aspect of the system affects all other parts. I hope with the unit students will implement green solutions into their own lives and influence others to do the same. Students will be required to make three improvements in their carbon footprint. Each change must be documented and approved. Each student must also teach three other people something they have learned about global warming which must include a list of green changes that can make a difference.

History of Global Warming

The subject of global warming and climate change is not a concept that has just crept into the headlines. Climate change has been investigated for a long period of time. Svante Arrhenius was the first scientist to suggest that carbon dioxide

from combustion engines could lead to the increase of our global temperature. Arrhenius made his claim back in 1896; he suggested that a doubling of the carbon dioxide level would lead to a 5 ˚C change in global temperature. His claim was made along with Thomas Chamberlain who helped him with his calculations (Enzler 1).

During the 1940's the area of infrared spectroscopy had experienced new developments. Scientists were now able to prove that carbon dioxide could in fact absorb infrared radiation (Enzler 1). The ability of carbon dioxide to absorb infrared radiation is found within the bonds of its structure. The double bonds of carbon dioxide allow it to vibrate like a spring at the correct frequency in order to absorb infrared radiation. The absorbance of infrared radiation leads to an increase of heat seen in raising the temperature of the environment. In order for infrared energy to be absorbed, the dipole moment must change while the molecule is vibrating (Wiley 559).

In 1958, a man by the name of Charles Keeling was investigating the rise of carbon dioxide in the atmosphere by placing instruments at the top of volcano Mauna Loa in Hawaii. Keeling felt as though this positioning would give him a reasonably accurate reading of the levels of carbon dioxide in our atmosphere. Keeling felt that conducting in research away from major sources of carbon dioxide, such as cities and the fluctuations of carbon dioxide levels near forests, his data would be accurate. Keeling was able to see seasonal fluctuations in the carbon dioxide levels. He also noted that levels although they fluctuated cyclically rose as well (Arms 181).

In 1988, global warming was being acknowledged and the United Nations and World Meteorological Organization founded the IPCC. The call letters IPCC stand for the Intergovernmental Panel on Climate Change. The organization consists of more than 60 countries from all over the world, as well as more than 2500 scientific and technical experts. The IPCC has continued to scrutinize their findings only to find more evidence to enhance their original findings. According to the IPCC, the warmest years on record have all been within the last ten years (Enzler 2).

Global warming is still regarded by many, as a scare tactic by the government to confuse the public. Change has been slow. Finally, the global community made a move and in 1998, the Kyoto Protocol was written. The Kyoto protocol requires countries to reduce their emissions of greenhouse gases by at least 5% below 1990 levels. The commitment period for the Kyoto Protocol is between the years of 2008 and 2012. The Kyoto Protocol was signed in 2001 by 186 countries. The most disturbing part of the entire process is that the United States and Australia have retreated from the Kyoto Protocol (Enzler 2).

Recently the global warming debate has gained great strides with the creation of Al Gore's, *An Inconvenient Truth*. The film was made as a response to all of the misleading information that has surfaced on the subject. The film presents evidence of global warming using a very dramatic approach.

The Greenhouse Effect

Planet Earth acts much like a greenhouse; the atmosphere acts much like the glass. The sun streams to Earth and heats the surface of the planet. As the sun's rays hit the Earth, a part of them, are reflected by the glaciers that are present on the Earth's surface. The heat that is generated also radiates up from the surface of the planet and into space, while various gases in the atmosphere trap some of the heat. Greenhouse gases include; carbon dioxide, nitrous oxide, methane, chlorofluorocarbons, halocarbons, ozone, and water vapor (Mader 474).

Carbon dioxide is naturally occurring on the planet and its concentration has been increasing at faster rates since the onset of the Industrial Revolution. Carbon dioxide is a result of the combustion process. The use of fossil fuels to heat homes, run vehicles and create electricity has all contributed to the increase of carbon dioxide in our atmosphere. The use of wood as a fuel also releases carbon dioxide into the atmosphere. The rate of carbon dioxide does fluctuate with the seasons due to natural processes such as photosynthesis and cellular respiration. The stripping of forests for mining and development also contributes to the amount of carbon dioxide that remains in the atmosphere. The oceans were once thought to be great carbon dioxide sinks due to the abundance of phytoplankton and other photosynthetic organisms. In recent times it has been calculated that the oceans can only absorb a third of the anthropogenic carbon dioxide produced (Enzler 2).

Nitrous oxide is generated by animal waste and is used as a source of fertilizers in commercial agricultural facilities. The use of nitrogen-based fertilizers is also used in the private sector of the agricultural field. As population grows the need for a larger farming industry will grow which will only compound the problem of greenhouse emissions.

Methane is naturally occurring and is produced by methane synthesizing bacteria called methanogens. Methanogens belong to the Archaeabacteria, which has the ability to produce methane in anaerobic conditions. These methanogens can be found at the bottom of lakes and in the bottoms of rice paddies. Methane

is released when these sediments are disturbed as in the harvesting of rice. Methanogens can also be found in the guts of animals (Mader 519)

Chlorofluorocarbons, such as Freon, were used as refrigerants. CFCs were also used in the production of Styrofoam, insulation and padding. In addition, chlorofluorocarbons were used as a propellant in aerosol cans. Since the realization that CFC's were destroying the ozone layer, their use has been stopped or limited by most countries. Halocarbons and ozone are greenhouse gases as well. Halocarbons are in fire extinguishers and ozone is present as photochemical smog in our troposphere (Mader 478).

The Layers of the Atmosphere

The atmosphere is mainly comprised of oxygen and nitrogen the remainder of its volume consists of trace gases. The atmosphere has several layers; each layer has its own unique characteristics. The layers of the atmosphere differ in temperature, density, and compositional make-up (Holt 598)

.

The troposphere extends from the surface of the Earth to 10 km above the Earth. Most of the atmospheres gases are located within this layer as well as the air we breathe. Most of the Earth's weather patterns occur within the troposphere (Arms 175). The troposphere is the densest layer of the atmosphere. The troposphere gets cooler as altitude increases. The density of the troposphere lessens as well. The temperature decreases by 6° C for every kilometer of altitude. The tropopause exists between the troposphere and the stratosphere (Holt 599).

The stratosphere sits directly above the troposphere; it extends from 10 km to 50 km above the Earth. There is some air current in the stratosphere, but not as much as the troposphere. The stratosphere contains the ozone layer, which protects us from the harmful ultraviolet rays of the sun (Arms 176). The stratosphere gets warmer as altitude increases. The stratosphere also contains very little water so storms do not exist (Holt 601).

The temperature begins to fall in the mesosphere. The temperature reaches its coldest point in the atmosphere at around -80° C. The thermosphere is the next layer in the atmosphere where the temperature gets very hot due to the fewer number of oxygen atoms in the air. Solar radiation is absorbed this heats the air to temperatures upwards of 980° C. The exosphere is located above the thermosphere some gases exit the Earth's gravitational pull while some gases are captured and added to the atmosphere (Holt 601).

Computer Modeling of Climate Change

Computer modeling of climate change is one tool that researchers have turned to in order to predict the future changes in the climate. There are many factors to take into account when modeling the climate of such a large system. Some factors are prevailing winds, seasonal changes, levels of carbon dioxide, as well as many other variables. The models themselves may differ due to the input of information from different sources (Arms 182).

The Earth also has feedback systems that come into play when calculating climate changes. One example of a feedback system would be the increased cloud cover due to evaporation of water. Extensive cloud cover can serve as a heat block; this would act as a negative feedback system. As ice melts at the Earth's poles, the surface of the Earth becomes exposed. Soil and rock generally has a darker color thus storing heat much like the asphalt shingles on the roof of a house in the summer time. The increase of temperature due to color change would act as a positive feedback process. Scientists have recently discovered that sulfur in the air due to polluting by coal burning tends to reflect the suns rays thus slowing the heating trend. These examples are all part of the complex equation needed to be examined when modeling the Earth's climate change (Arms 183).

Autotrophic Organisms

All organisms require a source of energy and a carbon source in order to grow and develop. Microorganisms may obtain their energy from light or chemical compounds. Microorganisms also obtain their carbon from carbon dioxide or organic compounds such as methane. The autotrophs are those microorganisms that use carbon dioxide as a sole source of carbon. They are able to use photosynthesis to generate organic substances (Lim 178).

Photosynthesis has two sets of reactions, the light dependent reactions and the light independent reactions. The light dependent reactions are the energy capturing reactions. The light independent reactions are the synthesis reactions this is where ATP is made in order to reduce carbon dioxide. The light independent reactions can take place in the absence of light (Mader 116).

The light dependent reactions do however supply the energy for the light independent reactions to reduce carbon dioxide into a carbohydrate form. The process of photosynthesis releases oxygen and sugar while using carbon dioxide

and water. The formula for photosynthesis shows the importance of autotrophs in the environment, for the fixation of carbon, whether it be in algae, bacteria, or plant material. The utilization of these organisms could be a major source of carbon fixation (Lim188).

Organic compounds made from the process of carbon dioxide fixation constitute a bulk of the organic matter found on the earth. However, polysaccharides are too bulky to pass through plasma membranes without being hydrolyzed into smaller molecules (Lim 191). The fact that these carbohydrates are insoluble makes them a candidate for carbon storage. The carbon dioxide from a tree that has fallen is not released at the time of cutting. The carbon dioxide that is within the tree is released over a slow period as the tree decays. If that decaying tree is buried and that carbon dioxide is trapped in the earth then this potentially could reduce the amount of carbon dioxide in the air. The release of carbon dioxide from fossil fuels is why the levels are as high as they are. Possibly the use of select cutting techniques could be the key to carbon dioxide reduction.

Deforestation

The deforestation of the Earth also has had an impact on the current global situation. The deforestation of the rainforest as well as other pressures to forest land such as fire, insect damage, and land development have contributed to climate change. The forests are a natural carbon sink. As Forests are eradicated, their potential to store carbon lessens.

As the world's population grows, more and more land is cleared for housing and food production. In 1999, logging and farming reduced the size of the Amazon rainforest by an area of the size of the state of Hawaii. The deforestation of the Amazon has continued to destroy patches of forest as we speak. As we add tons and tons of carbon dioxide to the air and at the same time remove trees from the planet, we enhance the progression of global warming (Fridell 29).

According to Pringle, "In the past ten thousand years, a third of Earth's forests have been cut down and not replaced" (37). Deforestation has reduced the air cleaning capabilities of the planet in conjunction with increased population and use of fossil fuels. Pringle goes on to say, "The pace of deforestation has quickened, and it accounts for roughly one-fifth of human's annual emissions of carbon dioxide" (37).

Many people who disagree with the facts of global warming will say that increased carbon dioxide is good for plants and thus enhances their living conditions. The fact is that each species of trees has specific guidelines with which it grows optimally. As the temperature rises, trees that are not adapted to the rise will scorch and lose the ability to photosynthesize effectively. The loss of leaf surface due to scorching does not allow the tree to convert the carbon dioxide to carbon-based molecules such as cellulose and sugars. The impact on forests may benefit the grow rate as long as the temperature does not exceed a specific species range. The rise in temperature also poses a unique set of problems, which deal with exploding populations of insects. In Alaska, populations of white spruce are falling prey to the bark beetle. The bark beetle is able to thrive due to increased average temperatures (Fridell 81).

Trees also produce a cooling effect through shading. Houses that are located near large stands of trees use less energy for cooling during the summer months. The presence of trees also helps local populations of animals and other plants by preserving habitats and microclimates that are the results of a forest eco-system (Pringle 37).

The planting of trees is certainly part of the solution to slow global warming. The establishment of large forest areas must follow certain guidelines in order to maximize the effectiveness. The planting of one species in a large area is called a monoculture. Monocultures do not absorb as much carbon dioxide as a mixed culture. Monocultures also make poor habitat for the general population of animals within a given area (Pringle 37). Care, must be taken, not to introduce foreign species to areas as they often compete with native species for the same resources. In order to maximize the resources of an area it is important to utilize the native species available.

The key to reforestation is to plant within urban areas as well. The benefit of trees in urban areas is that they utilize more carbon dioxide because concentrations are higher. A single mature tree can sequester up to 48 pounds of carbon dioxide a year. Each person in the United States releases approximately 2.3 tons of carbon dioxide a year. An acre of trees can sequester 2.6 tons of carbon dioxide per year. Therefore, to offset human released carbon dioxide an acre needs to be planted per person. This of course is not possible, but the absorption of carbon dioxide is beneficial, nonetheless (McPherson 1).

Solutions to Global Warming

There are many solutions to the global warming dilemma. The problem is they all take sacrifice and there will always be those that feel they are not responsible to take the sacrifice. The solutions to global warming that have been proposed, by the global community take funding to implement. The use of the fluorescent bulb instead of the incandescent bulb is recommended for reducing the output of carbon dioxide. The problem with the fluorescent bulbs is that they contain mercury, which in itself poses an environmental problem. The use of an insulating blanket on the water heater within the household will reduce the need for the combustion of gas to heat and maintain the water for doing dishes, washing clothes, and taking showers.

The increased planting of crops will also help absorb carbon dioxide. Many new studies are looking at the planting of certain grasses as carbon sinks. The use of no till gardening is also a proposed method of releasing less carbon dioxide to the atmosphere. Researchers feel that placement of organic material into the soil with limited amount of disturbance will help to store carbon dioxide. Although carbon dioxide is only half of the emission, we need to watch our consumption of the other greenhouse gases as well.

There are many alternative energy sources now being proposed. The use of ethanol has been in the news recently. Farmers who are planting it to produce this alternative fuel are now growing corn. The problem with ethanol is that it is not as efficient as gasoline. Another problem with ethanol is that it produces water vapor. Water vapor is a leading greenhouse gas. Another problem with the production of ethanol is the land use associated with growing corn. Now that farmers are growing, more corn it takes more land, which means fewer trees and less carbon sequestration. Still other problems associated with the production of ethanol include an increase in the price of other goods such as wheat products. Wheat has become less profitable so the prices of a sack of flour have sky rocketed because of increased demand.

The use of solar power has been researched over time as a source of energy. The problem with solar power is the expense of the panels and the lack of sunshine during winter months. Although solar power does not need to be the only source of energy, the question remains is it worth the effort for the average homeowner. If the average homeowner does not see a savings in energy bills, the probability of them switching to alternative forms becomes less.

The advantages to nuclear energy are numerous. A small amount of uranium can be used to power a nuclear reactor for years without having to be shut down except for maintenance. Nuclear energy does not produce any gases as those found with the burning of fossil fuels. The reason we do not use more nuclear energy is that it produces radioactive waste that is expensive to store, not to mention risky. Uranium stores are in short supply Uranium 235 has about a 100 to 200 year supply. Nuclear power plants are also extremely expensive to build and they are extremely complex to run (Holt 284).

Wind is also a source of energy that is being used to create electricity. The main disadvantage to wind generated electricity is that some regions do not experience enough wind to run the turbines. Wind turbines are large, often noisy, and not pretty to look at (Arms 641).

Hydroelectricity is efficient when the distance the water falls is great enough to rotate the turbines. The problem is most rivers do not fall these distances and dams must be constructed. These dams tend to ruin natural ecosystems and limit water supplies downstream. These power plants are also expensive to maintain (Holt 285).

No matter what alternative energy source or method is used to reduce the emissions of greenhouse gases is used a sacrifice must accompany it. The use of alternative energy sources is truly tailored to the area in which it will be utilized. The fact is methods of reducing the carbon emissions must still be researched in order to reduce the progression of global warming. A super solution will never be found. What may be found is an integrated plan to reduce carbon dioxide emissions and reduce global warming.

Objectives

Students will be able to explain and demonstrate how the scientific principles involved in the study of global warming have developed and evolved. They will be able to take these concepts and relate them to the current studies conducted by the IPCC. Students will also be able to demonstrate basic skills within the laboratory setting such as measurement, observation, data collection, and deduction. Students will be able to explain the technology of computer modeling and how it affects the current findings of the IPCC. Students will be able to construct models using basic equipment. Students will be able to draw conclusions from constructed systems that can be directly linked to global warming. Students will be able to draw on their knowledge base to explore the ethical issues presented by global warming. Students will be able to suggest

alternative forms of energy and other ways to slow the progression of climate change. Students will also get the experience of working in groups, and being part of a team. Students will learn how to integrate their ideas with those ideas of others.

Strategies

Students will be working in groups, structured so each student will fulfill a specific role. Group work will give students a chance to be part of a team. Students will also be using the Write Tools. The Write Tools is a system for writing effective essays. The system incorporates a number of writing strategies to help the student become a more concise writer. Students will use hands on activities in order to gain a fuller understanding of the concepts covered. The use of graphic organizers such as flow charts or two column note-taking tables is used. The use of a debate forum is used to get students to think about both sides of an argument. Students will be required to submit a culminating project that will include a poster and a model of a specific greenhouse gas. Students will also be required to provide evidence that they have informed others about strategies to combat global warming.

Classroom Activities

Day 1 and Day 2- C1, C2, C3, S1, S2, S3, S4

Students will be taken to the library where they will be researching the history of global warming. Each student must record at least ten facts found from the internet. The facts found will be added to a classroom discussion on global warming. A final essay will be written based on the information from the class.

Time Needed- Two class periods

Assessment- Students will be assessed on the essay that they write on the facts about global warming. The standard writing rubric is used.

Day 3- Day 4 C1, C2, C6, S1, S2, S5, S6, M1, M3

Students will be able to design an experiment in a plastic two-liter bottle.

Students must design the experiment that will show how conditions in the bottle will change when exposed to various variables. Such variables might include ice, water, sun, or soil. Students must decide what data is collected and they must then organize their data into a table as they collect it.

Time Needed- Two class periods

Assessment- Students will submit a formal lab report and they are graded on the effectiveness of their experimental design (Arms 192-193)

Day 5- Day 6 C1, C2, C6, S1, S2, S5, S6, M1, M3

Students must work in small groups, and research a greenhouse gas and make a poster that deals with its contribution to global warming. The teacher will assign the gas molecule that is used. The group must also construct the molecule in question. The poster and model then must be presented to the class. Students will design a rubric on how the project is to be judged.

Time Needed- Two class periods

Assessment- Groups are assessed on the accuracy of their project

Day 7-Day8 C1, C2, C6, S1, S2, S5, S6, M1, M3

Students will be able to demonstrate how oxygen is given off during the process of photosynthesis. Students will place a sprig of elodea in an upside down test tube the test tube is then submerged in water. The elodea is exposed to light. Students will be able to mark the outside of the test tube as to the amount of gas that is accumulating in it. Students will then expose the gas to a glowing ember and record their results. Students will also be able to demonstrate how carbon dioxide is the result of cellular respiration. Students will breathe into a solution of clear lime water. Students should be told that lime water turns milky in the presence of carbon dioxide.

Time needed- Two class periods

Assessment- Groups are assessed on a formal lab report with analysis questions prepared by the teacher (Mader 71).

Day 9-Day10 C1, C2, C6, S1, S2, S5, S6, S7, S8, S9, M1, M3

Students will be given the CD ROM the commons and be told to run through the various scenarios and answer the analysis questions at the end. The CD will allow them to model various situations using common space that is used by the global community. Students will then be asked to write a persuasive essay on an ethical issue such as nuclear power, carbon taxing, or alternative fuel sources. Each student is assigned a point of view. Students will then engage in a debate on their specific topic with each other.

Time needed-Two class periods

Assessment- Students will be graded on a standard writing rubric. The writing will be submitted as a portfolio submission.

Day 11 C1, C2, C6, S1, S2, S5, S6, S7, S8, S9

Students will be required to brainstorm ways in which to improve our carbon footprint. The teacher will provide a quick demonstration on alternative lighting sources, energy conservation, water conservation, and reforestation.

Time needed-One class period

Assessment- Students will need to provide documentation that they have talked to three people on the subject of global warming and that they have attempted to decrease their carbon footprint.

Bibliography

Emanuel, Kerry. *What We Know about Climate Change,* MIT Press Cambridge Mass. 2001.

Willaims, Mary E. *Is Global Warming A Threat,* Greenhaven Press, Farmington Hills MI. 2003.

Fridell, Ron. *Global Warming,* Franklin Watts Publishing, United States of America.

Green, Kenneth. *Global Warming: Understanding The Debate,* Enslow Publishers, N.J. 2002.

Pringle, Lawrence. *Global Warming: The Threat of Earth's Changing Climate,* Seastar Books, N.Y. 2001.

Holt, *Spectrum Science,* Harcourt Books, N.Y. 2001.

Miller, Kenneth. *Biology,* Prentice Hall, N.J. 2002.

Lim, Daniel. *Microbiology,* McGraw Hill, N.Y. 1998

Arms, Karen. *Environmental Science,* Holt, N.Y. 2000

Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, N.Y. 1992

Mader, Sylvia. *Biology,* McGraw Hill, Boston, Mass. 1998

World Wide Web

Climate Change, www.epa.goc/climate change

Global Warming Interactive, http://science.nationalgeographic.com

Global Warming Research Issues, http://solar-center.stanford.edu

Global Warming and Clean Energy Maintenance, www.sierraclub.org/global warming

Global Warming Facts Sheet, http://www.ecocentre.org.uk

Biology Online, www.biology-online.org

Intergovernmental Panel on Climate Change, http://www.IPCC.CH

Appendix A

Content Standards for the Pittsburgh Public Schools

Science and Technology

1.) All students explain how scientific principles of chemical, physical, and

biological phenomena have developed and relate them to real-world situations.

2.) All students demonstrate knowledge of basic concepts and principles of physical, chemical, biological, and earth sciences.
3.) All students use and master materials, tools and processes of major technologies, which are applied in economic and civic life.
4.) All students explain the relationships among science, technology and society.
5.) All students construct and evaluate scientific and technological systems using models to explain or predict results.
6.) All students develop and apply skills of observation, data collection, analysis, pattern recognition, prediction and scientific reasoning in designing and conducting experiments and solving technological problems.
7.) All students evaluate advantages, disadvantages and ethical implications associated with the impact of science and technology on current and future life.
8.) All students evaluate the impact on current and future life of the development and use of varied energy forms, natural and synthetic materials, and production and processing of food and other agricultural products.
9.) All students demonstrate basic computer literacy, including word-processing, software applications, and the ability to access the global information infrastructure, using current technology.

Reading, Writing, Speaking and Listening

1.) All students use effective research and information management skills, including locating primary and secondary sources of information with traditional and emerging library technologies.
2.) All students read and use a variety of methods to make sense of various kinds of complex texts.
3.) All students respond orally and in writing to information and ideas gained by reading narrative and informational texts and the use of information and ideas to make decisions and solve problems.
6.) All students exchange information orally, including understanding and given spoken instructions, asking and answering questions appropriately, and promoting effective group communications.

Mathematics

1.) All students use numbers, number systems, and equivalent forms (including numbers, words, objects and graphics) to represent theoretical and practical situations.
2.) All students apply the concepts of patterns, functions and relations to solve theoretical and practical problems.