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It Ain't Easy Being Green

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Introduction

I quote Kermit the Frog to illustrate the argument that it is not easy to be “green”. It is difficult to change decades of a mindset that is allowing abuses of Earth’s atmospheric, terrestrial, and aquatic provisions for the sake of human comforts.

As man evolved, the importance of finding shelter, food sources, heating, clothing, etc. were of the utmost priority for survival. The discovery of fossil fuels would answer, and meet most of the needs. Oil, coal, carbon, and natural gases found in various states of matter were the major components (in the fossil fuel category) enhanced to accomplish the requirements for survival. Lives were progressing along maintaining a “somewhat” symbiotic relationship with the environment until the Industrial Revolution. The Revolution invoked energy consuming habits that found humans seriously threatening this homeostatic relationship.

In this age of instant gratification and technological advancements, humans have put more stress on Earth’s health than any other time in geologic history. Fossil fuels are now being interpreted as villains destroying Earth’s natural biome. It is not fossil fuels in general that are responsible for our environmental damage, rather the abuse of over consuming those energy sources that has placed mankind in a delicate balance that has fatal repercussions if not addressed.

I feel it imperative to introduce and establish a curricular unit for my students to identify energy sources, and their overconsumption, establish effective ways to reduce personal usage, and in turn become Green Ambassadors to further educate our K-8 students. It is my hope to pattern a new paradigm following the Peace Corps advice “Think Globally Act Locally”.

Background

Windmill Springs Elementary School is one of twenty-one schools in the Franklin McKinley School District located in the East Side area of San Jose, California.

Franklin McKinley is a Title 1 school district. The neighborhood demographics find families that are generally Asian and/or Hispanic, single parent households, families with gang affiliations, ones where English is not the primary language nor is it encouraged to be spoken at home, grandparents and other guardians raising students (due to parental issues), and middle-class families.

Windmill Springs has an enrollment of 618 students whereas 65% are classified as socio-economically disadvantaged.[1] This coming school year Windmill may be facing a declining enrollment due to Charter Schools and families relocating to other counties due to economic reasons. Windmill Springs is a K-8 campus where older students are looked to be role models and help the younger ones with their schoolwork. Many siblings attend Windmill so teachers get to know families and their students' needs a little more than the traditional elementary school model.

In adopting Common Core standards one major criterion is Project Based Learning melding with traditional curricula to facilitate a deeper knowledge and understanding of content. I know in my personal practice, Design Challenges have instilled in the students a means to assimilate specific theories and principles on a much deeper level. In my research, I found means to teach this unit on a much different, more defined mode to accommodate their learning styles.

Rationale

The greenhouse effect is a natural manner of maintaining a suitable temperature on Earth to support and maintain life. The term greenhouse effect originates from the agricultural model. A greenhouse functions by allowing sunlight to enter through the roof, and atmospheric gases (usually carbon dioxide along with water) are trapped and absorb the energy (heat) during the day to keep the heat inside. At night as the temperature cools, inside the structure the "heat" that was absorbed is retained warming the environment to maintain a suitable temperature for survival. With the natural form of a "roof" being a cloud cover, one can get a rudimentary view of the phenomena called global warming.

Carbon dioxide is a major greenhouse gas. Its effects are far reaching. As mentioned above the greenhouse effect is a function that is necessary for all life to occur, and endure on Earth. The problem arises when there is too much carbon dioxide being released by artificial means.

Soon after Earths' formation the atmosphere contained about 95% carbon dioxide.[2] Plant life started to appear. As plant life evolved the spreading vegetation absorbed the carbon dioxide, and as it decomposed stored it in the form of carbon rich coal, and oil deposits.[3] Carbon Dioxide levels continued to fall to the point where humans and animals could now call Earth home. Throughout Earths' existence there have been temperature variations that have created ice ages, severe droughts, and other weather related catastrophes. Each one of the aforementioned catastrophes shaped terrestrial, aquatic, and atmospheric environments differently, yet always correcting them to make life habitable for all inhabitants. Up until the Industrial Revolution, horticulture and agriculture played an enormous role in the intake and release of the Carbon cycle. Plants absorbed the carbon dioxide and produced oxygen as a byproduct. Trees would absorb and sequester the carbon. Naturally occurring incidences like decomposing plants or forest fires released the carbon back into the atmosphere thus continually repeating the cycle. The Industrial Revolution sped up and introduced other forms of environmental hazards. Burning Fossil Fuels for energy production greatly

increased the “greenhouse effect” on Earth.

Not only do carbon dioxide and other greenhouse gases effect climate change they unleash economic and cultural consequences as well. A metaphor I use with my students is the one where you take a stone and toss it into a pond. The ripples that emanate from the center are the consequential displays relating to the stone’s action. The buzz words greenhouse gases, global warming, or climate change illustrate the stone, whereas the “rippling” action signifies the economic, societal, and cultural plights triggered by the build up of carbon dioxide.

Example**s** I share with my students concerning the economic ripple would be climate driven - Hurricane Katrina. When preceding storms occurred, economic help was given to some residents though not all almost immediately in some form or another. The storm was the one of the largest in history to hit the U.S. mainland. Projected to be a category 3 storm, Katrina made landfall and in fact had transformed into a Category 5 storm with winds in excess or 200 m.p.h.[4] Damage to homes, businesses, surrounding areas, and loss of life were tantamount to the severity of financial claims brought on by Katrina. Decades earlier, the sea level was lower and the levees encompassing high-risk areas were deemed to be extra “insurance” structures that would keep water surges in check and away from residents and businesses. Many did not feel compelled to evacuate thinking they could and would sustain the intensity of Katrina. Others could not, but felt they would be taken care of. Since Katrina there have been other disasters; however, insurance companies determined that disasters that were created by man’s irresponsible actions did not have to be covered, and in most cases were not covered. Another case in point is one in which outsourcing takes center stage in creating greenhouse gases. By sending industries, and commodities to other countries for manufacturing purposes, more carbon dioxide is expended in the shipping and the worldwide distribution of merchandise. Not only are we losing labor forces due to outsourcing, we are losing ground on renewable energies.

Two cultural topics teens need to discuss and be aware of are what footprints they are creating due to their choices in food and transportation. Fast food marketing and corporations depend on their business and aspire to come up with promotions to keep one step ahead of the competition. Bigger burgers, the 5-dollar meal combo – we have all seen the advertisements to entice teenagers to buy fast food from their establishments. They fail to advertise that the beef in their meals require a great deal of energy to produce and cows are responsible for a majority of methane gas being dispersed in the atmosphere (cows are one of the main producers of methane). If meat consumption is reduced by six meatless days a month the energy saved will be the equivalent to that saved when you switch from driving a sedan to a hybrid vehicle.[5]

Transportation adds another layer to their “footprint”. No longer should they be using the car to go to school, do local errands, or being dropped off to meet friends at the mall. Teens need to be cognizant of the amount of carbon dioxide emitted from their car’s exhaust when they are being dropped off at school, or being driven to the mall. The U.S. Environmental Protection Agency documented that neighborhood schools reduce traffic, produce a 13 percent increase in walking and bicycling, and a 15 percent reduction in emissions of concern.[6] Using public transportation to get to malls will further decrease the emission statement.

Objective

Most middle school students develop an internal sense they need to become more aware of the outside world and the major issues that are instrumental in shaping their future. Media plays a massive role in accessing information that formulates their viewpoints. Students need to understand the importance of stepping away from traditional social media, and add a new facet of media, a segment that is called social responsibility. Being “plugged in” their world is open to travel anywhere in cyberspace. For most of them they do not, or have not been exposed to the darker side of technology. Technology can be a double edge sword – unlimited possibilities await their inquisitiveness. In using technology they need to know that they are creating a carbon footprint (or adding to their carbon footprint). Their actions generate carbon emissions using phones, tablets, gaming devices, and/or laptops . Most need to know (some already do) that powering off, but still plugging into power sources adds to their footprint.

In order for students to gain an active role in social responsibility and mapping their carbon footprint, they need to recognize the significance of influences leading to the excessive warming or cooling of Earth. One does not recognize water vapor as a greenhouse gas however, when changes occur in the concentration of water vapor in the atmosphere the results are deemed feedback loops. When carbon dioxide is overly abundant it warms the atmosphere to the point where more than the usual amount of surface water evaporates which can add more warmth to our planet. The intensification of vapor present creates a positive feedback loop. On the other hand if low clouds become prevalent in response to increased carbon dioxide, cooling can occur to counter the warming effects creating a local negative feedback loop.[7] The cooling effects will be felt on a global basis.

Concepts

While researching information concerning fossil fuels, climate change, and greenhouse gases I found what I thought I knew about those topics was not going to be anywhere close to the information I needed to prepare and effectively teach my unit –entitled “Carbon Footprints”. For one I discovered most of the information I had available to be at least eight years or older. I also went through an intense phase deciding what information to include and / or omit in my unit. I finally decided to base my curricular unit on the following concepts: the Industrial Revolution starting after 1800, exhibiting the enormous rise in the presence of carbon dioxide, methane, and chlorofluorocarbons (the most notable greenhouse gases), Two parts of photosynthesis, Fossil Fuels, Electricity, Methane and Carbon Dioxide being the two gases the students could research readily for their “footprints” project, and my unit on Carbon Footprints.

Another concern that I found haunting me was the length of the curricular unit. I felt four weeks would be adequate to address the main segments of my unit namely the carbon cycle and mapping the carbon footprints however, when I really understood the process and found that it was going to be difficult to adequately teach all the necessary components, I started thinking I might have to extend the time of my unit. At this time, I am going to really take a hard look at the components I have listed and see realistically how much time I really need. This is my first time executing a year long project so I want to be able to adjust my timing so all phases of the project get met.

Industrial Revolution

To start with, I needed to review more succinctly the sources of energy prior to the 19th Century. Energy mainly came from natural sources - plants, animals, water, sunlight, and wood. Nature and mankind resided in a relatively symbiotic relationship. The 19th Century was significant because of the inception of the Industrial Revolution. The need for energy (power) development to fulfill the growing needs of the populous led to the discovery of fossil fuels (coal, oil, and natural gas) as a major energy source. Replacing the old sources with fossil fuels ultimately led to the production of more efficient machinery, increasing the demand and supply of the fuels. Thomas Newcomen first invented the steam engine and it was used to pump water out of coalmines. James Watt improved the design and productivity of the steam engine, and was credited with bringing it to all branches of the economy.[8] The steam engine opened the world to machines that not only powered factories, but also railways and ships. Another source of power to rival steam was electricity.

Photosynthesis

Photosynthesis is the process used by plants, algae, and certain bacteria to manufacture food for their survival, and release oxygen into the atmosphere as a byproduct. "Without photosynthesis, the oxygen in the atmosphere would be depleted within several thousand years".[9] Oxygen is not the sole reason for photosynthesis. Plants synthesize glucose and carbohydrates for their food source. Eating fruits and vegetables insures animals and humans alike will receive the energy necessary for survival.

Photosynthesis is a two-stage process that harnesses energy from sunlight (visible and infrared) and converts it into chemical energy. The two stages in photosynthesis are light- dependent reactions, and the Calvin Cycle. During the first part of photosynthesis, light energy splits water into hydrogen ions, electrons, and oxygen molecules. Light-driven water splitting affords the electrons and energy for the production of ATP and NADPH (chemical energy).[10]

Calvin Cycle

The second stage of photosynthesis is called the Calvin Cycle. The Calvin cycle is a series of chemical reactions that occur as part of the light independent processes of photosynthesis. Carbon is broken away from carbon dioxide, and energy from the ATP coupled with electrons from NADPH combine to manufacture glucose, and carbohydrates.[11] For the purpose of this paper being utilized as an elementary/ middle school unit, it tends to be a simplistic interpretation of the Calvin cycle.

Photosynthesis functions as a counterbalance to respiration; it takes in the carbon dioxide produced by all breathing organisms and reintroduces oxygen into the atmosphere. This is the basis for all plant growth, and indirectly all animal life.[12] It is interesting to note what carbon dioxide is not used by the plant is returned to the atmosphere by manner of respiration.

Fossil Fuels

Fossil fuel is the generic term for biological material (decayed plants and animals matter) that has been buried for centuries. Over the ages extreme pressure acted upon matter thus turning the decayed substances into crude oil, natural gas, and coal. Fossil fuels were formed. Since this fuel source was created before the dinosaurs appeared it earned the term fossil fuel.

Carbon obtained its' name from the Carboniferous period found in the Paleozoic era.

The terrain in this geologic period was designated to have massive swamplands containing enormous pits that were being filled with biological material – trees, ferns and other plant life. The waterways were filled with algae. Algae are a plant that is the combination of thousands of tiny plants and bacteria. When the plant life died it sank to the bottom of the pits, and waterways, and was converted into peat (a combination of plant material and roots). Over the next thousands of years, the peat became covered with sedimentary rocks that had formed from pressurized waste materials. Layers of rocks were stacked upon each other. Over the course of time the buried plant material that was covered with peat, was converted into fossil fuels. Fossil fuels are discovered being in solid, liquid, or gas states of matter.

Solid

Coal is the major example of the solid state of Carbon. Coal is thought to be formed by the combination of pressure, heat, and time acting upon plant remains (also known as peat). Peat is a biologic structure that is composed of plant roots, branches, decayed plants and other life forms that underwent massive changes.

Coal is a form of cheap energy. Burning coal has powered just about every piece of machinery invented during and after the Industrial Revolution. The internal composition of coal makes it highly flammable due to its being plant based. The supply was and still is vast enough so using it as an energy source makes sense to the nonscientific person. The problem using coal as an energy source is coal is primarily composed of plants. Plants contain carbon. Burning coal releases carbon dioxide into the atmosphere. The amount of carbon dioxide being released and contained in the atmosphere is now approaching dangerous levels.

Liquid

Crude oil is the main liquid form of fossil fuels. Another lay term for crude oil is petroleum. In nature, oil is found well beneath Earths' surfaces (land and water). Like coal and other fossil fuels it is composed of primitive decomposed substances mixed with sedimentary materials. As stated above, the process of layering decaying materials with rock coverings created extreme heat and pressure environments. As geologic time continued the heat and extreme pressure liquefied the organic material and crude oil was formed.

Gas

Natural gas was discovered in shale rock, coal deposits, or sandstone reservoirs[13] It is usually found in reservoirs running along side coal deposits. Methane is the main component of natural gas. Two other forms of natural gas are propane, and ethane, however methane is the one most prevalent of the natural gases.

As man evolved he sought fossil fuels for survival purposes. Burning the fuel source as evidenced in our readings kept him warm, and warmed his food. Progressing through the epochs, the fossil fuel was being coveted for other purposes. It was now being sought after as a major power source. Industrialization found new uses for coal, oil, and natural gas. The fuels would now be used to power steam engines, turbines, and generators making electricity available to a vast number of people. Electrical power was also sought to modernize transportation, and fuel the economies of the countries that could afford this luxury. While fossil fuels were modernizing life for some cultures, they were opening up Pandora's box and becoming the source of global conflicts.

Electricity

Electricity was the symbol of a more efficient power source. By the 1920's Samuel Insull created an electric

empire stretching across the Midwest to the East. “Every home, every factory and every transportation line will obtain its energy from one source, for the simple reason that will be the cheapest way to produce and distribute it”.[14] Fossil fuel burning for energy purposes – manufacturing electricity from power plants by coal, oil, or natural gas was opening up a new paradigm for society. The more electricity that was being consumed by the population, the higher the levels of carbon dioxide/ methane gases in the atmosphere would become apparent.

In the early stages of electrical power, coal was the main source of fuel utilized to produce electricity. Coal would be burned to heat water. Water turned to steam, which would rotate the turbines rapidly, and the turbines would direct their power to the generators thus producing electricity. Nowadays there are other ways to produce electricity; however, coal seems to be a major player in producing electricity. There is no doubt that coal will continue to play a major role in producing the world’s electricity. Electrical power companies in the United States are expected to add 280 500 - megawatt power plants by 2030.[15]

Greenhouse Gases

As stated before, greenhouse gases keep the earth habitable in their natural state. When the three major greenhouse gases: carbon dioxide, methane, and chlorofluorocarbons, are in surplus amounts, problems ensue. One major issue is the long-term impact of greenhouse gases on global warming. Some gases absorb energy more than others. “Carbon dioxide is not the strongest absorber, however being present in large amounts dominates the rest of the gases. Methane absorbs energy more effectively than carbon dioxide. Carbon fluorine compounds are energy sponges. Their potential to contribute to global warming is enormous”.[16] As of 2008 the average lifetime of greenhouse gases in the atmosphere was as follows: Carbon dioxide 100 years, Methane 12 years, Nitrous oxide 115 years, and Chlorofluorocarbon 45-1700 years.[17]

Methane

Methane and Nitrous Oxide are greenhouse gases that absorb infrared radiation stronger than Carbon Dioxide. Methane has a climate warming potential 3.7 times stronger than Carbon Dioxide (Methane and Nitrous Oxide are released into the atmosphere by decomposition of plant and animal matter abundant in landfills), however in Third World countries a vast amount of gases are emitted from the farm animals, and the burning of dung for heating purposes.

Methane is the second most prevalent greenhouse gas emitted in the United States from human activity. In 2014 Methane accounted for 10.6% of all U.S. gas emissions from human activity.[18] Methane has shorter “life” expectancy than carbon dioxide; nonetheless it traps more radiation energy than carbon dioxide. Industry, agriculture, and home usage are the top producers of methane. Methane is the leading element in natural gas. It is emitted during all the phases of natural gas production. Natural gas usually is found alongside petroleum production, which forces more methane into the atmosphere.[19]

Livestock produce a sizeable amount of methane gas. Methane production comes from their digestive processes. Storage of manure accounts for a high number of emissions.

Homes and industries send their garbage, wastewater, plant and animal waste to landfills to be buried. As the matter decomposes Methane is released into the atmosphere. Waste and decomposing organic materials have also been found in wetlands. In the absence of oxygen bacteria will break down the material and release methane.

Carbon Dioxide

Statistics display a sobering message to everyone concerning the health of Earths' atmosphere and oceans. In the 30-year period spanning 1960 – 1990 carbon dioxide levels released in the above environments have risen from 57% to 80%.[20] Oceans are absorbing Carbon Dioxide at a rate that is making the seawater toxic to its' inhabitants. Coral Reefs are becoming severely bleached not only killing them but the creatures that depend on them for survival. Sea life is absorbing levels of toxins that will eventually poison anything that uses them as a food supply.[21]

On a global scale carbon dioxide flows between two great reservoirs: the atmosphere, which contains 1% of the carbon pool; and the oceans, lakes, and rivers containing 71% of the carbon pool.[22]

The key sources of carbon dioxide emissions are: electricity generation, transportation, and industry. The estimated total of carbon dioxide being used from those key sources per American is believed to be roughly twenty tons a year.[23]

The combustion of fossil fuels to generate electricity is the largest single source of carbon dioxide emissions in the nation, accounting for about 37% of total U.S. carbon dioxide emissions and 30% of total U.S. greenhouse gas emissions in 2014.[24]When producing electricity from coal, more carbon dioxide will be released into the atmosphere than any other source manufacturing electricity.

Transportation

According to the EPA the burning of petroleum, gasoline, or diesel fuel for the purposes of transporting people, and goods is the largest single source of carbon dioxide emissions in the U.S. accounting for 37% of the total carbon dioxide emissions, and 30% of total greenhouse gas emissions in the U.S. This particular category includes cars, airplanes, railway, and marine vessels.

America is a mobile society. The East Coast transit system is far superior to the West Coast in the categories of ridership, routes and efficiency. The West Coast is far more spread out in its highway system, and general transit routes. People do not want to, or cannot use mass transit systems due to the inefficiency of there travel grid organization.

The Federal Transit Administration estimates that switching to public transportation instead of driving would allow the average American to reduce his or her carbon footprint by 10 %. [25]

Carbon Footprint

A carbon footprint is defined as the amount of greenhouse gases produced either by a primary or secondary manner to support daily activities. Sometimes simultaneously along with the above-mentioned manners the carbon footprint includes greenhouse gas emissions as well. Driving a car creates a certain amount of carbon dioxide being emitted depending on how much fuel is being consumed, and the distance the car travels. Heating the house with oil, coal, gas or electricity generates amounts of carbon dioxide. Buying food and products are responsible for carbon dioxide emissions due to the nature of their production. The carbon footprint is a formidable instrument to understand the impact of one's contributions to global warming. It is a powerful means to display amounts of carbon dioxide generated by activities, and the need to reduce the amount personally. Students need to be aware of and to take responsibility for identifying their footprint, and reducing their use of carbon dioxide. Throughout the year they will generate graphics proving that one person

can make a difference.

Strategies

At the beginning of the year students will be provided with background information on the origin of greenhouse gases - especially carbon dioxide and methane, and how their usage relates to the evolution of the crisis we face today. It wasn't until after the Industrial Revolution that their use began to build up in the atmosphere faster than they could be safely dispersed without causing detrimental effects to Earth's inhabitants.

Demonstrations will be provided to strengthen an understanding of the importance of tracking carbon dioxide emissions. Worksheets will be used along with videos as a preliminary check on their background knowledge of greenhouse gases. As the first few weeks progress they will develop ways in which to brainstorm reducing their personal outputs of carbon dioxide in the following categories: water usage, using electricity, food consumption, driving as opposed to walking, and travel. They will color pre- made footprints using the specific color that pertains to the behavior being tracked giving them a visual representation.

As the months progress behaviors should change. They will develop habits of saving water, "green" electricity usage, practice reducing, recycling, and reusing methodology generate a tracking system for monthly carbon consumption identifying the way in which energy - gas, electricity, water, and travel, is used and abused in their own, and gradually their family's lives. Graphs, charts and posters will be generated displaying their findings class wide (also on a monthly basis), to provide visuals, and encourage everyone's participation in becoming socially responsible to their environment. This is a great way to display how one person can make a difference in helping to heal our planet.

This is a beginning year for the Carbon Footprint project so the unit will be discussed somewhat on an ongoing basis throughout the school year, and will culminate with an Earthday Fair on Earth Day. The curricular unit will last approximately 5 – 6 weeks as the issues of carbon dioxide's adverse effects on our world and wellbeing is brought forth and taught.

Throughout the year the students will construct the booths, produce environmental checklists, and introduce personal ways for all students to reduce environmental waste, and be able to track their own "footprints", and be made available to all K-8 students and their families at the Fair.

The students will also choose 2 students from each grade level to join their "green team" to learn and help with the Fair. The younger students will be coached by the older team members throughout the year and be asked to participate along side their respective team at the Fair. As subsequent years progress students will have an opportunity to evolve the Carbon Footprint project and Earthday Fair into challenging other classrooms, schools and communities to join in their cause.

The carbon footprint is a formidable instrument to understand the impact of one's contributions to global warming. It is a powerful means to display amounts of carbon dioxide generated by activities, and the need to reduce the amount personally.

Activities

Guiding Questions

Guiding questions will be formed for students to critically think about the project and how they are going to become a member of a bigger 'family' than their own. At the beginning of each lesson, the students will have questions to answer as journal entries.

As time goes on, the students will be developing their own guiding questions and coming up with ecologically sound answers. I stress again this is especially valuable to second language learners. Their teammates will be able to aid their understanding by reciprocal teaching methods. Those being: identify what information the question is really asking about; ask for clarification if not sure of answers; answer any questions that arise in their discussions; and finally generate another question to be asked later. This is a good activity for all students to improve their language skills.

In addition to guiding questions, curricular readings, discussions, and journaling will all be an integral part of the project. Students will be interweaving technology with engineering practices by visiting websites and participating in their own generated web quests. They will be creating going green activities, identifying and calculating carbon usage, designing their exhibits for the culminating project, and producing power point presentations. The power point presentations will feature not only the eighth graders, but also younger students who have been selected to work with on them on teams. Participating in writing, directing, and producing monthly green living tips will serve as a public service message and will be distributed to all respective grade levels.

Lessons

Industrial Revolution

Guiding Questions

1. Which two scientific advancements affected society the most?
2. Why did the industrial revolution start in Great Britain?

Students will be grouped in fours. They will read and review primary source documents from this time period. The documents can be obtained on line by accessing the Library of Congress - sub topic Industrial Revolution. Students will discuss with group members and generate a chart depicting inventions found and their effect on society. The next day they will do a jigsaw activity with each member from the group joining another group. Students will then discuss their findings and choose which inventions had the most effect and create a time line representing those inventions. Assessment can be having the students write a cause and effect essay using the information from the time line.

Greenhouse gases

Guiding questions

1. What are greenhouse gases?
2. What benefits do they offer Earth?
3. What happens when greenhouse gases increase in the atmosphere?

Lesson will exhibit a modified greenhouse effect increasing temperature.

Students will be paired up with each other and given two plastic cups or small jars. They will fill both containers with two to three inches of dirt (potting soil), and moisten the soil with water using a spray bottle. One of the container's tops will be covered with plastic wrap and secured with a rubber band. In approximately 15 minute intervals "inside temperature" will be taken from both. The thermometers need to be above the soil line. When accessing the plastic covered container for temperature recording purposes pay careful attention to limiting outside exposure time- as you are reading and recording the inside temperature. Place your information in your notebook. On the next day, chart temperatures and times on graphs and discuss your findings.

Carbon Footprint

Guiding questions

1. What impact does your footprint cause within your community?
2. What are you going to do to commit to reduce your "prints" on a monthly basis?

There are four separate lessons in this unit. The Carbon Footprint worksheet found online at www.championenergyservices.com will start the students thinking about their involvement in the production of greenhouse gases.

"How Big is Your Carbon Footprint?" www.energystar.com, further explains the adverse effects carbon presents to their health, to the environment, and provides a comprehensive approach to protecting our environment. Students will find the carbon footprint (provided in the handout) to fill in along with the carbon footprint survey. Completion of the survey will draw a more realistic picture to their personal carbon consumption.

"How Big is Your Family's Carbon Footprint?" invites students to color and label each family member's footprints. Specific instructions are provided on how to chart the amount of carbon each family member produces.

Finally the "Go Green Family Challenge" will have family members pairing up and competing against each other to see who is the biggest carbon offender in their household. For single parents or guardians teams can be adjusted accordingly.

All of the above worksheets except for the Carbon Footprint worksheet are available from www.energystar.com website. The worksheet can be accessed through www.championenergyservices.com.

Resources

Student

Books

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Teacher

Books

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www.ecologicalfootprintnetwork.org

www.energystar/gogreenactivities

www.3epa.gov

www.meetthegreens.pbskids.org/info

www.nature.org/initiatives/climatechange/calculator

www.teachengineering.org/lessons "What Kind of Carbon Footprint"

www.windows2universe.org/earth/climate/carbon_cycle.html

“Carbon Cycle Game”

Notes

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Excellent source for definitions, interactive games, and up to date articles.

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Footprint Facts. New York: Dover Publishing Co. 2010. Eco-friendly coloring

book presenting facts pertaining to usage, waste, and recycling materials. Demonstrates how to reduce carbon footprints

Berners-Lee, Mike. How Bad Are Bananas? The Carbon Footprint of Everything.

Vancouver: Greystone Books, 2011. Book is engaging to readers. It tracks a

persons' carbon footprint from birth to death, and encourages rigorous discussions

on a wide range of ecological topics.

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Appendix Implementing Next Generation Science Standards

This curricular unit will address NGSS standards and satisfy district-learning outcomes for Science, Technology, Engineering, and Mathematics. The new NGSS standards are grouped in the grades levels 6-8. Eighth grade standards are being followed. Information obtained through NGSS website accessed July 18, 2016

NGSS Standards

PS3.A: Definitions of Energy

- The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (Secondary to MS-PS1-4)

Influence of Science, Engineering and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3)

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-

PS2-3), (MS-PS2-5)

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1), (MS-PS2-4),

Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-PS2-1)

(MS-PS3-1)

Systems and System Models

- Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. (MS-PS3-2)