

Climate Change: Informing the Next Generation

Christina Johnson
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Final

Introduction

The audience for introduction into climate change is an eighth grade earth science class. This particular audience was chosen for selection due to the students ability to focus, understand logic, and problem solve. Students in this class will become the next generation of adult producers and consumers that are still at an age where influence is possible. Being pre-exposed to the earth science curriculum has allowed the students to be understanding of most topics and terms discussed throughout the presentation.

The audience will predominantly be presented information on climate function, evidence of current climate change, as well as the policies put in place to combat climate change. Although deeper understanding of how emissions such as methane and carbon dioxide change the radiative forcing in our climate system is important, a more general presentation will give the students the basics needed to make changes to their interactions with the environment. These basics are designed to introduce the students to important information that they can use in real world applications with hopes it will foster further positive behaviors and habits.

A hands-on approach will be most effective in presenting valuable information regarding climate function and ways change can and will be mitigated. Allowing students to engage in discussion and hands-on practice will reinforce the information being presented. Information must be presented in a structured yet light manner in order to ensure all students remain engaged and participating in all activities.

Commentary

The attention of the audience will be gained through humor, passion, and excitement regarding the topics of discussion. A brief background will be presented by the presenter as an

ice-breaker in order to allow the students to become comfortable with the presenter. A smooth transition between topics must take place in order to ensure students remain attentive and engaged. Objectives will be introduced before the core of material is presented. These objectives will be introduced by name by the presenter which will segway into a ‘shout-out’ of information regarding the topic based on the student's current understanding of the objectives. The presenter will list the information the students present as a way for students to ‘look back’ and see what points may or may not have been correct. From there, the students will have an opportunity for discussion as a way to understand what information was incorrect as well as why the correct information is important.

Key terms such as carbon dioxide, methane, greenhouse gas, climate change, climate system, emission, and regulation will be discussed throughout the presentation. The presenter will ask the students to define the terms in a shout-out format before the presenter states the exact definition along with an example that pertains to the current state of conversation.

Definitions for these students are as follows:

Carbon Dioxide - a gas that is produced when people and animals breathe out or when certain fuels are burned and that is used by plants for energy (Merriam-Webster, 2016)

Methane - a colorless odorless flammable gas that consists of carbon and hydrogen and is produced by decay of organic matter (Merriam-Webster's Student Dictionary, 2016)

Greenhouse Gas - any of various gaseous compounds (such as carbon dioxide) that absorb infrared radiation, trap heat in the atmosphere, and contribute to the greenhouse effect (Merriam-Webster, 2016)

Climate Change - a change in the typical or average weather of a region or city (NASA, 2011)

Climate System - The meteorological conditions, including temperature, precipitation, and wind, that characteristically prevail in a particular region (The Free Dictionary, 2016)

Emission - the act of producing or sending out something (such as energy or gas) from a source (Merriam-Webster, 2016)

Regulation - an official rule or law that says how something should be done (Merriam-Webster, 2016)

Upon the end of the presentation, the presenter will give each student pamphlet or packet with all key information discussed for the students to return to for further guidance and understanding of the topics being presented.

Climate System and Function

The Earth's climate is manipulated by many factors that all interweave to create the environment in which we live. Orbital cycles, energy transfer, and anthropogenic interference all contribute to how our climate functions.

Milankovitch cycles are caused by changes in the way the earth orbits around the sun. The shape (eccentricity), wobble (precession), and tilt of the Earth's axis (obliquity) all have different effects on how much of the sun's energy reaches the planet (North Carolina State University, 2012). The orbit (eccentricity) changes over a period of 100,000 years from a near perfect circle, to an oval, and back again as a circle. When the orbit becomes a pronounced oval, earth would be warmer as it's closer to the sun and the seasons would be different (North Carolina State University, 2012). Obliquity is defined as the earth's tilt in relation to the earth's

orbit around the sun. This tilt is what causes the seasons. When the tilt becomes larger, the seasons become more extreme. When it becomes smaller, the seasons are milder with less differentiation between them (North Carolina State University, 2012). The wobble of the earth upon its axis is referred to as the precession. This wobble changes where the North Pole points into the sky (North Carolina State University, 2012).

Energy transfer throughout landmasses, the oceans, and the atmosphere begins with solar energy. Polar regions receive solar energy at a shallow angle meaning it obtains less heat. Equatorial regions receive solar energy at more perpendicular angles with maximum obtainment of heat (Indiana University, n.d.). The uneven heat distribution around the globe assists in the currents and movement of the oceans and atmosphere in order to distribute the energy. The oceans store more heat than land surfaces due to water's ability to contain more heat. Oceans cover approximately 70% of the earth's surface causing it to be a heatsink and a natural temperature buffer between the ocean and the atmosphere. Atmospheric circulation causes wind to blow over the oceans creating drag and starting the movement of surface water (Indiana University, n.d.).

The anthropogenic interference on earth has resulted in climate changes which intensify the natural climate cycle processes. Of those, the greenhouse effect is of most concern. When sunlight reaches the earth, it is either reflected or absorbed. Once absorbed, the energy may be partially released back into the atmosphere (US EPA, 2016). Gases such as water vapor, carbon dioxide, and methane absorb this energy or slow its release into space. This absorption results in the atmosphere creating a blanket-like effect and makes the earth warmer. This process is known as the greenhouse effect (US EPA, 2016).

When sunlight reaches the earth, it is either reflected or absorbed. Light colored objects such as snow and clouds typically reflect this light while darker objects such as forests and the ocean tend to absorb it (US EPA, 2016). The reflection of sunlight is affected by aerosols that can either be warming or cooling. Aerosols such as particles from a volcanic eruption have a cooling effect on the climate, either locally or globally. Human activities have resulted in a general increase of aerosol particles in the atmosphere and have been found to offset about one-third of the total climate warming (US EPA, 2016).

Evidence of Climate Change

Recent climate change has been significantly studied in order to understand the current climate state as well as predict future changes. A study in which results were released in July 2016 has shown that cloud patterns have shifted since 1983 (The Washington Post, 2016). This study is important as it shows the relationship between clouds and global warming. Clouds are fundamental regulators of solar radiation and longwave radiation emitted from Earth. The poleward shift in clouds has caused an expansion of subtropical dry zones by 20-30 degrees latitude in the northern and southern directions (The Washington Post, 2016). This shift has resulted in storms that bring water to many areas to track more north or south and further escalates current drought conditions.

Recent changes in global climate are determined through observation and detailed data collection due to the creation of modern technology. Past climate changes are more difficult to determine but have been able to be identified through the use of isotope reactions in materials. Approximately 12,000 years ago the Earth appeared to be coming out of an ice age but saw a reversal back to glacial conditions that lasted at least 1,000 years (Pennsylvania State

University, 2015). This event appears to have been centered in the North Atlantic ocean and is known as the Younger Dryas. This rapid cooling resulted from a slowdown or collapse of the ocean's thermohaline circulation in response to the influx of freshwater from the melting of ice sheets and glaciers (Pennsylvania State University, 2015).

If current actions are maintained, the Earth will continue to see climate changes that may be difficult, if not impossible, to adapt to. If global temperatures rose by 1 degree Celsius, Andean glaciers may disappear and threaten water supplies for 50 million people (New Scientist, 2007). A 2 degree Celsius increase would cause water availability in regions such as South Africa and the Mediterranean to decrease by 20-30% (New Scientist, 2007). The same increase could result in a high risk of extinction in Arctic species such as polar bears and caribou. There is a high risk that the West Antarctic ice sheet as well as the Atlantic thermohaline circulation could collapse in a 3 degree Celsius rise in temperature were to occur (New Scientist, 2007).

If the world population were to consume every ounce of available fossil fuels, the Earth would experience a warming of approximately 16 degrees Celsius (MAHB, 2013). Such an increase would eliminate grain production on a global scale leading to starvation. A current alternative to fossil fuels is the use of nuclear power. Although pollution is non-existent with nuclear energy, it is not a perfect energy source. Nuclear power plants require access to large volumes of water and are often situated near large bodies of water (New Scientist, 2011). Coastal regions experience storms and sea level rise that may compromise these facilities should storms increase in intensity as sea levels rise. Should the opposite occur and sea levels drop or water temperature increase, nuclear facilities would be unable to operate (New Scientist, 2011).

Based on current and historical data, scientists have developed climate models in an attempt to predict future climate change. In all scenarios, a likely temperature increase of 2.7 degrees Fahrenheit should occur by the year 2100 (US EPA, n.d.). The most aggressive climate model expects the global average temperature to increase over the next 100 years by nearly double of that in the previous 100 years (US EPA, n.d.). For every 2 degrees Fahrenheit temperature increase, models project a 15% decrease in annual Arctic sea ice while the Greenland and Antarctic ice sheets are expected to continue to melt adding to the rise in sea level (US EPA, n.d.).

Climate Mitigation: Policy and Politics

Over the last several decades, global climate change has become an increasing concern. Many countries have convened and signed international agreements in an attempt to mitigate current and future effects of climate change. These agreements have become more important as scientific data has indicated temperature and weather pattern changes will continue to increase.

The Kyoto Protocol is an international agreement that commits its members members to emission reduction targets. This protocol was adopted in Kyoto, Japan on December 11, 1997 and began to be enforced on February 16, 2005 (United Nations Framework Convention on Climate Change, 2014). Its first commitment period started in 2008 and ended in 2012. On December 8, 2012 the “Doha Amendment of the Kyoto Protocol” was adopted to extend the protocol through 2020 and includes a revised list of greenhouses gases that are in need of reduction (United Nations Framework Convention on Climate Change, 2014).

During the first commitment period, 37 countries committed to reducing greenhouse gas emissions by five percent. The second commitment period resulted in the same parties agreeing

to a reduction of emissions to 18 percent below 1990 levels (United Nations Framework Convention on Climate Change, 2014). During these commitment periods, the participating countries have their emissions monitored and must maintain precise records that are submitted to a registry system for tracking in order to determine that the rules are being followed.

The United Nations Framework Convention on Climate Change (UNFCCC) was entered into force on March 21, 1994 and currently has a membership of 197 countries (United Nations Framework Convention on Climate Change, 2014). This convention is one of three adopted at the “Rio Earth Summit” in 1992 with an ultimate goal of preventing dangerous human interference with the climate system by stabilizing greenhouse gas concentrations (United Nations Framework Convention on Climate Change, 2014). Developed countries were determined to be of most importance in leading the international goal of climate change mitigations. Developed countries must also financially support future actions on climate change mitigation in developing countries and is managed by the Global Environment Facility (United Nations Framework Convention on Climate Change, 2014). Under the UNFCCC, industrialized countries must regularly report on their climate change policies as well as an annual inventory of their greenhouse gas emissions.

In the United States, much debate regarding climate change is contained between democratic and republican political parties. This wasn't always the case as republicans were supportive of Theodore Roosevelt's role in promoting the conservation of natural resources by establishing national parks and forests and democrats supported Franklin Roosevelt's attempt at including conservation as part of the New Deal (Environment Magazine, 2008). Collaboration between the two parties was evidenced by republican president Richard Nixon signing several

important environmental legislations into law in the 1960s and early 1970s (Environment Magazine, 2008). This situation began to change in the 1980s as the Ronald Reagan administration began to label environmental regulations as a burden on the economy. This sentiment was echoed in 1994 when Republicans assumed control over congress (Environment Magazine, 2008).

Current studies have shown that more republicans are convinced that the climate is changing. Yale and George Mason universities conducted a study that determined that forty-seven percent of conservatives agree that the climate is changing (Scientific American, 2016). This accounts for the single biggest change among all political parties and could symbolize a turning point in climate change policies. Seventy five percent of republicans and ninety one percent of democrats support funding of renewable energy sources while similar numbers support tax rebates for individuals who purchase energy efficient items (Scientific American, 2016).

The change in climate change perception is important given the scientific data available to individuals on a global level. The current United States presidential administration has focused this information and has developed a roadmap for national and international leadership in climate mitigation. These policies and plans have been put in place based on the known drivers of climate change. Carbon dioxide, methane, halocarbons, and nitrous oxide are greenhouse gases and are produced in a variety of ways. These gases are long lasting and have a positive forcing, or heating effect, on our environment (American Museum of Natural History, n.d.). Ozone, on the other hand, is a short-lived greenhouse gas that has increased in the troposphere while being depleted from the stratosphere. This increase in tropospheric ozone has had a much larger impact

on climate change and has had a positive forcing effect (American Museum of Natural History, n.d.). The increase in greenhouse gases and their effects have been significantly offset by negative forcing by aerosol particles. These particles scatter incoming sunlight in all directions including out to space which in turn causes negative forcing (American Museum of Natural History, n.d.).

To combat these effects, the Environmental Protection Agency has developed carbon pollution standards for new and existing power plants. In 2014, the EPA released the Clean Power Plan (The White House, n.d.). The current presidential administration has also proposed the toughest fuel economy standards for passenger and commercial vehicles in U.S. history.

Conclusion

Human (anthropogenic) interference and influence has become a major driver in climate change. The increased use of fossil fuels for electricity, product development, and transportation has resulted in an uncontrolled amount of pollutants such as carbon dioxide and methane to be introduced into the atmosphere. As levels continue to increase, the functionality of our climate begins to decline. Over development of land for agricultural use and housing of a booming population has resulted in major changes to ecosystems that have altered the way our environment and climate naturally neutralize particles in the atmosphere. Until all populations are educated and dedicated to discontinuing the use of fossil fuels, at best countries can attempt to adopt policies that are implemented in concentrated locations in hopes of offsetting pollutants from other areas or countries. Implementation and creation of new technology to sequester and prevent the emission of pollutants should be of international concern. When technology is created, it should be made readily available to all at a price that is fair. Although global

government agreement is unlikely, so is oversight and regulation. A fair market for new technology and techniques will support a global economy and allow countries around the world to take advantage of growing markets that support a healthy climate and renewable energy sources.

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