



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2015 Volume III: Physics and Chemistry of the Earth's Atmosphere and Climate

Potential Causes of Climate Change

Curriculum Unit 15.03.03
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Rationale

Education has been divided among different disciplines for years, but true learning takes place when students recognize the relevance of learning across disciplines. My colleague, Patricia Sorrentino, an English teacher, and I co-teach a science and English course called "Science through Literature." Within this course, we cover science topics with a high concentration on non-fiction literature. Having both of us in the class, with different skills and abilities, helps the students learn the information on a deeper and more relevant level.

We teach under-credited and overage students at New Horizons School for Higher Achievement in New Haven, Connecticut. Our students have been placed in our alternative high school for reasons of truancy, criminal records (court-ordered students), childcare issues, and serious behavior issues. Most of them live in poverty-ridden neighborhoods and find school to be their only "safe-haven," but fall way below their reading/writing grade levels, so schoolwork is difficult and frustrating. My job is to teach the New Haven science curriculum at an appropriate level, so none of my students feel over- or under-challenged, which is quite difficult when I have a class of fifteen students and reading/writing levels vary from "grade 2" through "post-high school." Another huge challenge is their truancy issues. In my class of fifteen I may only see the same three students every other day, so the units and lessons I plan cannot span over a couple days because I will only be forced to play "catch-up" each day with the students who walk into the classroom after three days of being absent.

Our co-taught class has focused on topics of disease and viruses, astronomy, genetics; and now, we want to focus on climate change. Climate change, however, is a huge topic, which our students find boring and irrelevant. What we hope to accomplish is an awareness of how climate change affects each of our students and what they can do to help make changes. With the upcoming election, we want to help our students become scientifically- and politically-literate when it comes to the issue of climate change.

In order to do this successfully, we will first focus on the foundational information they need to understand the issue and how it started. Once the foundation has been built, we will focus on political debates and news articles. Our students will conclude the unit with a debate of their own—defending or arguing climate change.

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articles. In addition, we will utilize our school’s garden, the Long Island Sound, and other nearby amenities to conduct experiments and hands-on learning. Our students will conclude the unit with a debate of their own—defending or arguing against the notion of climate change.

Thomas Hager’s *The Alchemy of Air* will be the first text we examine. We will not read the entire book, but will take sections of it to explore the history of climate change. This book travels through the beginning of the twentieth century when humanity was facing a global disaster. The fast-growing population was facing a mass starvation fear. Two of the world’s most brilliant scientists, Fritz Haber and Carl Bosch, were called in hopes of finding a solution. These two scientists developed, what is now known as the Haber-Bosch process. Their invention still feeds us today, but at a significant price. The Haber-Bosch process was also used to make gunpowder and high explosives, which killed millions during the two world wars. As a result of their invention, today we face massive nitrogen pollution. To follow this text, we will focus on James Hansen’s TED Talk “Why I must speak out about climate change,” Scientific American’s “Behind the Hockey Stick,” “The Nitrogen Cycle,” and “What Do Farmers Think about Climate Change?”

Overview

This unit will span over the course of a marking period, which is about 45 days of teaching. Each week, a new text will be the focus. To accompany the text, during-reading lessons and activities will take place. The final 2 weeks of the marking period, students will work to formulate their arguments in preparation for their final project—an in-class debate.

Importance of Interdisciplinary Co-Teaching

Definition of Co-Teaching

Co-teaching is a model that emphasizes collaboration and communication among all members of a team to meet the needs of all students. Two teachers are equally qualified and equally responsible for the teaching within the joint class. For interdisciplinary co-teaching, the two teachers should be skilled in two different subjects (for example, Alva Hanson is a science teacher and Patricia Sorrentino is an English teacher). The needs for successful co-teaching are communication between co-teachers, administrative support, similar philosophies, and common planning time.

The Purpose of Co-Teaching

These co-teachers come together for a common purpose, typically to meet a wide range of learners more effectively. These teams may have a long-term agenda for working together (an entire academic year) or short-term agendas for working together (completing a unit together, science project, etc.). The purpose for interdisciplinary co-teachers is to bring two teachers with different skill sets into one class for better classroom management, higher student engagement, and deeper learning for students.

How Co-Teaching Works

Two teachers from different disciplines have to decide they can work well with each other inside and outside of the classroom. Then they have to decide what topic they want to teach and what parts of the unit each teacher is responsible for. The most important piece of scheduling for this type of co-taught class is knowing which course credit each student needs. For example, in our co-taught class, students who need a science credit are enrolled with the science teacher, Alva Hanson, while students who need an English credit are enrolled with the English teacher, Patricia Sorrentino. Once the pair of teachers is established, students are enrolled, and a unit is developed, the class can run smoothly. Students will be able to learn the material with an in-depth focus of two different disciplines.

Why Climate Change?

There are many topics that the Science curriculum teacher and English curriculum teacher could cover in a science and English-merged course; however, climate change is so widely discussed there is an acute need for students to be "in the know" on this politically charged topic. Our students, who are mostly Black and Latino, will encounter more of the negative effects of climate change because of their poverty and inner-city living. Climate change is attributed to the burning of fossil fuels, which adds to pollution. Our students tend to live in the areas where there is a higher concentration of pollution due to power plants, cars, and industry; thus, our students are more likely to breathe in dirty air than people of a higher economic status living in the suburbs. The burning of fossil fuels is changing our climate, which heightens the possibility of super storms. For example, Hurricane Katrina hit the people of New Orleans with a vengeance. These impoverished citizens are still waiting, 10 years later, to be compensated for their losses. Due to their economic status and lack of resources, they were unaware of the danger headed their way and did not heed the evacuation warnings. We want to educate our students, so they do understand the severity of super storms, so if they are ever faced with that type of catastrophe, they are prepared. Also, many of our students suffer from asthma and other health issues related to pollution. In addition, urban areas tend to have heat islands, which attribute to further health risks. If we can use this unit to educate our students about climate change and its effects, we can help make them better consumers and better voters. While we are concerned about the environment, we are also concerned about human rights—all citizens should be able to breathe in clean air and have clean energy options.

Health Effects and the Marginalized

To introduce the negative health effects associated with climate change, our students will view the graph on the <http://www.cdc.gov/climateandhealth/effects/> website. The graph outlines the different health issues associated with climate change, such as asthma and cardiovascular failure. The graph shows what specifically causes these health issues; for example, poor water and food supply can and do lead to malnutrition. The English co-teacher will create a cause and effect flow chart with our students for better comprehension (see Political Debates over Climate Change by Patricia M. Sorrentino).

To bring this issue closer to home for our students, we will view a CBS video. The video, accessible on <http://www.cbsnews.com/news/obama-on-impact-of-climate-change-on-health-of-one-of-his-family-members/>, deals with President Obama's direct correlation with climate change; he blames climate change for one of the

many causes of asthma. Many of our students suffer from asthma, much like Obama’s daughter. Asthma has been proven to be on the rise due to climate change. Asthma can severely affect one’s quality of life. To best understand asthma, we will explore the structure of the lung, how the respiratory system works, and how asthma affects the functions of both.

The article on <http://www.webmd.com/lung/how-we-breathe> will help break down how breathing happens, the structure of the lung, and how the respiratory system works. The video on YouTube, <https://www.youtube.com/watch?v=7EDo9pUYvPE>, will explain how asthma affects the lungs. Since many of our students suffer from asthma, they will have experience with dealing with this struggle.

Finally, we will ask our students to conduct a survey of their friends and family to find out how many have been diagnosed with asthma. This survey will provide data for our students to analyze. I will have my students create a graph to insert their data, so they can visualize the numbers they have collected. With this information, the English co-teacher will ask all of the students to create informational posters to hang around the school building (see Political Debates over Climate Change by Patricia M. Sorrentino).

Foundational Knowledge

Atmosphere

Prior to reading any texts, we need our students to understand the structure of the atmosphere. In order to effectively teach our students the different layers of the atmosphere, we will watch this video on YouTube: <https://www.youtube.com/watch?v=WaikvaAw2nk>. This video explains the compositional layers of the atmosphere and the major characteristics of each layer. This is important for our students to understand because climate occurs in the atmosphere, which is directly impacted by climate change.

Basics of Climate Change

Prior to reading our texts, we will expose our students to the foundation of climate change. The English co-teacher will review and define terms necessary to understand this topic (see Political Debates over Climate Change by Patricia M. Sorrentino). This video on YouTube—<https://www.youtube.com/watch?v=3v-w8Cyfoq8>—will introduce the effects of greenhouse gases on our atmosphere and to our climate for our students. In addition, the video provides an understanding of how the Industrial Revolution had a huge effect on our climate because of a spike in burning fossil fuels.

Energy

Once our students view the first two clips, we will have them watch two other clips, which focus on energy. The YouTube clips are: <https://www.youtube.com/watch?v=wMOpMka6PJI> and <https://www.youtube.com/watch?v=20Vb6hILQSG>. The first video explains renewable and nonrenewable energy. The video first explores energy and the different types of energy. The video also explains that energy is not unlimited and reviews ways to conserve. This video will be an introduction to our field trip to the power plant. The second video explains how energy is created. The focus of the video is a generator and how it functions.

Close to our school is the Yale Power Plant, which we will plan a field trip to visit. On this field trip, our students will experience how energy is created. Once they have viewed the energy video clips and visited the power plant, they will create a simple shake generator.

In class, our students will be provided with the materials to make a simple shake generator. The website, www.creative-science.org.uk/gensimple1.html, is a great source for instructing a shake-a-gen. Making a simple generator will help show our students how electricity is produced. A generator works because the magnets are stimulating the electrons in the wire coil. The magnet moving back and forth creates alternating current (AC). Alternating current is created when the electrons are moving back and forth through the wire coils and the LED (light emitting diode). The stimulated electrons passing through the wires of the LED causes the LED to light up.

The materials necessary for this project are a 35 mm film canister, thin insulated copper wire, magnets that just fit in canister, scissors, sandpaper, red LED, and tape.

The following steps should be followed:

- Remove the lid of the 35mm plastic film canister.
- Cut out two cardboard circles about 50mm diameter and cut out their centers (33mm diameter hole), so that they fit snugly onto the canister. Space the two circles about 1cm either side of the center of the can. Wind on a few turns of insulation tape on to the can, either side of the cardboard to hold them in place.
- Use the cardboard circles as a bobbin (or former) on which to wind the coil. Wind on 500 to 1000 turns of thin, insulated copper wire. Add a layer of electrical tape to keep them from un-winding. Remember to leave about 10cm or so of wire free at each end.
- Scrape off some of the insulation (say 5mm or so) from the ends of the wire (using sandpaper) and connect to the LED (it does not matter which way round). Solder the connections if possible. Use some electrical tape to secure the wire and LED to the bottom of the can.
- Pop a small (but powerful) magnet into the can and snap the lid back on. Hold the can between thumb and forefinger at the two ends of the can (with thumb or forefinger on the lid to stop it coming off) and shake. The LED will light!

Classroom Activities

During-Reading Lesson/Activities

In order for our students to best understand fertilizers, their functions, and their effects, I will conduct a hands-on series of activities. Many environmentalists, who are eager to educate our youth about the important issues, have created researched-based educational websites and learning tools. One fantastic tool is www.TheScienceofSoil.com. Educators can find PowerPoint presentations, hands-on activities, and demonstrations for free to enhance their classroom. Within this website, there is an important PowerPoint presentation titled, "Fertilizers and the Environment."

Objectives for this lesson:

- Recognize that farmland is a finite resource
- Appreciate that the world’s growing population demands an increase in food productivity
- Describe the role fertilizer plays in increasing food productivity
- Distinguish between organic and commercial fertilizers
- Describe how excess nutrients are harmful to the environment
- Identify different sources of nutrient pollution

Once the PowerPoint presentation is complete, we will use our school garden as an experiment. We will test the soil in the garden and inquire about fertilizers used to help the garden grow. After testing the soil and figuring out what fertilizers are used, our students will create a suggestion list for our garden coordinator, in order to sustain our garden in an environmentally-friendly way. The English co-teacher will facilitate this piece of the unit (see *Political Debates over Climate Change* by Patricia M. Sorrentino).

James Hansen’s TED Talk “Why I must speak out about climate change,” Scientific American’s “Behind the Hockey Stick,” and “The Nitrogen Cycle” will be the next informational texts we read. All three texts provide more of the foundational knowledge our students need to help them understand the issue. “Why I must speak out about climate change” discusses Hansen’s knowledge of climate change and his fears for the future. He outlines the evidence, which points to climate change and brings to light the possible negative effects. “Behind the Hockey Stick,” discusses Michael Mann’s highly criticized, but iconic hockey stick graph, which makes predictions for our world with the effects of global warming. Mann defends his scientific predictions, but receives push back from skeptics, such as the Greening Earth Society and the Tech Central Station Web site, because they obtain funds from petroleum interests. Petroleum is made from fossil fuels, so it is not in the interest of some to agree with global warming due to the financial implications. However, Mann’s prediction did not come true, which has led many skeptics of climate change to point to his graph with many questions. “The Nitrogen Cycle” discusses how a large majority of the population cannot utilize nitrogen. Nitrogen can only be used once specialized organisms fix it or when industrial processes take place. Fertilizers allow the nitrogen to be utilized, in order to farm; however, this is harming our environment. This article touches upon the issue of money, which is in control of everything—this brings us to the political issues connected to climate change. These two articles provide necessary information before we can move on to more in depth articles and debates.

During-Reading Lessons/Activities

A big underlying topic in the three texts is CO₂, so I will provide my students with an understanding of what CO₂ is and have them conduct experiments to experience what CO₂ does. While there are many great videos, the video titled, “What to do with CO₂,” will engage our students. The video also does a great job of breaking down complex information into a cartoon clip. It can be found on the following website: www.wonderville.ca/asset/whattodowithCO2. Once our students have viewed the video, the English co-teacher will read an informational text about CO₂ (see *Political Debates over Climate Change* by Patricia M. Sorrentino). These two activities will help provide the necessary foundational information about CO₂ for our students.

In order to engage our students and help them “see” CO₂, we will conduct the following experiments:

- Inflating Balloons—the objective of this experiment is to teach students that there is a chemical reaction between vinegar and baking soda and explain that CO₂ is a product of the reaction.
 - Add two tablespoons of baking soda to a balloon using a funnel.
 - Add eight tablespoons of vinegar to an empty plastic bottle.

- Put the end of the balloon over the opening of the bottle, being careful not to drop the baking soda into the bottle just yet.
- Ask students to hypothesize what will happen when the baking soda and vinegar mix and what will happen to the balloon.
- Let the baking soda drop into the vinegar and watch the balloon inflate.
- Revisit the students' hypotheses and discuss results.
- Bubbling Sandwich Bags—the objective of this experiment is to further teach students about the acid-base reaction between baking soda and vinegar.
 - Preparing four toilet paper squares filled with two tablespoons of baking soda; twist or fold the edges of the toilet paper to seal in the baking soda.
 - Fill one plastic sandwich bag with four tablespoons of vinegar, another with eight tablespoons, another with twelve tablespoons, and a fourth bag with four tablespoons of vinegar plus four tablespoons water.
 - Students should know that the reaction between baking soda and vinegar produces carbon dioxide gas. Ask students to hypothesize what will happen to the plastic bag once the toilet paper and baking soda bombs are added to the vinegar. They should also hypothesize which bag will inflate the most, or if they think the bags will pop, which bag will pop first. Ask if they think the vinegar diluted with water will make a difference.
 - Test your hypotheses by adding the baking soda bombs and quickly sealing the bags; the carbon dioxide makes the bags pop because there's more gas than they can hold. Take this experiment outside to prevent an indoor mess.
 - Review the students' hypotheses and discuss the results.
- Carbon Dioxide and Breathing—the objective of this experiment is to test the acidity of carbon dioxide gas using red cabbage juice as a pH indicator.
 - Make red cabbage juice by boiling shredded red cabbage in two cups of water for ten minutes; the juice should be purple. Tell students that the cabbage juice turns blue if exposed to a basic substance, but it turns pink when exposed to an acid.
 - Put one teaspoon of cabbage juice into one small plastic cup, labeled "control" and another teaspoon into another cup labeled "test."
 - Put one end of a straw into the test cup.
 - Ask students which color they think the juice will turn when they blow into the other end of the straw.
 - Blow through the straw for a few minutes and watch the juice turn pinker than the control—does this mean the carbon dioxide you breathe out is acidic or basic?
 - Test this theory further by adding regular water to a cup of cabbage juice and then carbonated water to another cup of cabbage juice.
- Soda Explosion—the objective of this experiment is to test the reaction of diet soda and Mentos candy.
 - Ask students what they think will happen if they add the candy to a two-liter bottle of diet soda. Will this supposed reaction change if there are varying amounts of soda in each bottle, or will the reaction change if you add only two candies instead of four, six or eight?
 - Test these hypotheses by placing four bottles of diet cola on a table outside (do not conduct this experiment indoors). Test only one variable at a time, so try either varying amounts of soda or candy. The explosion of bubbles occurs because ingredients in the candy break the attraction of water molecules and encourage carbon dioxide bubbles to form.

These experiments, combined with the foundational information, will help our students understand CO₂, so

when reading about it and its effects on the environment, they can better understand human uses of the gas.

Scientific American's "What Do Farmers Think about Climate Change?" will be the text to follow because it deals with our current effects of climate change and how we, as a society, are impacted. This article outlines farmers' beliefs of the reality of climate change. However, these farmers are skeptical of those who are trying to make necessary changes because of the political influence. This text is another resource to help us discuss the political implications of climate change and will help direct us to understanding the political debates for the 2016 electoral debates.

During Reading Lessons/Activities

While we read the above article, we will also focus on the website, www.epa.gov/climatechange/science/causes.html, in order to gain more insight. While the English co-teacher does a close-read activity with the article (see Political Debates over Climate Change by Patricia M. Sorrentino), I will describe and discuss the charts and illustrations.

Each of the graphs and illustrations highlights an idea relative to understanding natural causes and human causes of climate change. In addition to understanding the charts and videos, we will calculate our carbon footprint. This activity will be done online at www3.epa.gov/carbon-footprint-calculator/. The objective of this activity is to help our students understand how much carbon they admit through their daily activities. We hope to have our students become more mindful of their contribution to the environment.

Ways to Address Climate Change

Transportation Efficiency

We will discuss fuel efficient cars and compare and contrast different vehicles. As an activity, students will choose two different vehicles and have to compare their fuel efficiency and emissions. They will have to determine the best choice of vehicle for themselves and the environment.

Transportation Conservation

We will discuss public transportation, carpooling, biking, etc. As an activity, students will have to campaign around school to get more of their peers and teachers to conserve when dealing with transportation. They can choose from a brochure, poster, YouTube video, etc. in order to get the word out around school that transportation conservation is important to the future of our environment.

Building Efficiency

We will discuss how buildings are designed and the energy they need. They will have to design a "Green Building" in order to prove their understanding on how to conserve energy when building a mall, movie theater, or apartment building. They will also have to design the layout of the landscape. They will incorporate trees, water, etc. as a way to describe how to make the building run more efficiency.

Efficient Energy Production

We will discuss how to properly insulate a home, in order to use less heat. We will also discuss shutting the water and lights off when we are not actively using them. We will discuss weather proofing homes and finding ways to use renewable energy. Our students will have to find 10 ways to save energy and reduce its production within their day-to-day lives.

Field Trip

To culminate the mitigation of climate change section of the unit, we will visit Kroon Hall, which is a sustainable building at Yale University. After the field trip, students will be able to compare and contrast the differences of a “regular” building and a “green” building. They will be able to discuss the economic and social benefits of a green building and how they best serve our environment.

Final Project

To culminate the unit, students will be asked to participate in a formal debate. The class will be divided into two groups—those defending climate change and those arguing against climate change. As a science teacher, my job will be to provide the students with the science information to understand climate change. I will guide them in understanding the ideas presented in the texts. The English co-teacher will focus on the assessing and analytical skills of reading non-fiction texts. She will provide them with guidance in formalizing an argument and defending it for the debate.

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Appendix

This unit utilizes the Next Generation Science Standards. A combination of middle school and high school standards have been included, due to the population of my students.

- HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
- HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Since this unit is coupled with an English Language Arts unit, the following cross-curricular standards will be utilized:

RST. 11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS3-1) ,(HS-ESS3-2),(HS-ESS3-4)

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-2),(HS-ESS3-4)

WHST.9-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)

This unit focuses heavily on the 21st Century Competencies. All of these competencies will be incorporated into the students' classroom activities and projects.

- Problem Solving and Critical Thinking:
 - Reason effectively

- Make insightful judgments and decisions
- Solve problems
- Accessing and Analyzing Information
 - Use research tools to access and evaluate information from multiple sources
 - Organize and synthesize information using multiple methods
- Communication and Collaboration
 - Articulate ideas clearly and effectively to a variety of audiences using multiple modes
 - Communicate effectively and work productively with others
- Creativity and Innovation
 - Demonstrate originality and inventiveness in work by, implementing and sharing new ideas
- Initiative, Leadership and Accountability
 - Set and meet high standards and goals for one's self and others
 - Manage time and resources to produce high quality results in a timely manner
 - Take responsibility for one's own learning
- Citizenship and Responsibility
 - Exercise empathy and respect for diverse cultures and perspectives
 - Contribute to and take responsibility for the larger community

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