OUR CHANGING CLIMATE

Grades 6-12

WILL STEGER FOUNDATION

Dear Educator:

Climate change is a reality. It threatens both our society and life as we know it on earth. The overwhelming consensus of the scientific community for the past decade has been that the planetary warming we are now experiencing, and the resulting climate change, is largely a human induced phenomenon. This is brought on mainly by the release of carbon dioxide through the burning of fossil fuels, which blankets our atmosphere raising the earth's surface temperature.

Environmentally, we see dramatic signs of climate change in our polar regions. Yet, because these regions are remote and go unseen by most people, it's easy to ignore the potent warnings. The Will Steger Foundation's founder, Will Steger has been to both poles and seen the catastrophic consequences of the effects of climate change. He crossed both the Ward Hunt Ice Shelf in the Arctic and Larsen A and B Ice Shelves on Antarctica, which have since collapsed into the sea in the last two decades as a result of climate change. He experienced firsthand the melting of the sea ice on the Arctic Ocean, and in the spring of 2008 traveled through the ruins of the Arctic Ocean's melt from the previous summer. That same year on the Greenland ice cap, he was confronted with rivers of water at 7,000 feet during the summer; unprecedented at that elevation!

If we educate ourselves and re-connect with our community, we can reduce our fossil fuel consumption and eventually chart a different course for the Arctic and the rest of the globe. We need discussion, engagement, but also the desire to live a bit differently than we have until now. Your efforts are critical to our success.

Action begins with education and climate literacy and climate change must be an essential topic in the educational agenda. This agenda begins with a sound educational curriculum based on best practices in educational research and pedagogy and continues with teacher education and professional development. Because we are dealing with an immediate threat and opportunity, we must launch a public education campaign to educate everyone. I invite you to be a part of this effort by incorporating climate change concepts into your teaching which have been included in this guide and are available free for download at www.willstegerfoundation.org. Let's begin the process of changing the way we live so that we can mobilize and act to make a difference.

Thank you for your dedication to climate literacy,

The Will Steger Foundation Education Team

Table of Contents

Our Changing Climate 6–12 Lesson Organizer

Lesson/Objectives	Lesson Materials
LESSON 1: OUR UNIQUE ATMOSPHERE 40 minutes • Explain how heat-trapping gases work in the atmosphere • Explain why carbon dioxide and other heat-trapping gases are necessary for life as we know it	Reading 1: The Structure of the Atmosphere Reading 2: Heat-Trapping Gases in the Atmosphere Reading 3: The Greenhouse Effect
LESSON 2: EMISSIONS OF HEAT TRAPPING GASES 40 minutes • Explain how increased atmospheric concentrations of heat-trapping gases warm the atmosphere • Predict what will happen to global temperatures if atmospheric concentrations of heat-trapping gases increase • Identify sources of heat-trapping emissions • Calculate a carbon footprint • Identify ways they can reduce their carbon footprint	Handout 1: Energy Use in Your Home Image 1:Greenhouse – Green Planet Image 2: 1000 Years of Changes Image 3: Carbon Dioxide in the Atmosphere Handout 2: 20 Simple Steps to Reduce Climate change
LESSON 3: COMMUNITIES OF LIVING THINGS 40 minutes • Explain how changing weather patterns, a changing balance of competitors and changes in the availability of food and shelter can increase uncertainty for communities of living things • Give examples of these uncertainties and disruptions from the Arctic communities • Predict how continued warming may affect communities of living things with which they are familiar	Reading 1: Polar Bears Reading 2: Ice-edge Dwellers Reading 3: Land-Dwellers Reading 4: Plant Communities Reading 5: Human Communities
LESSON 4: IMPLICATIONS OF WARMING IN THE ARCTIC 40 minutes • Explain feedbacks including surface reflectivity (albedo), ocean circulation, melting permafrost releasing heat-trapping gases and melting ice contributing to rising sea levels • Explain how warming in the Arctic affects the rest of the world	Feedback 1: Surface Reflectivity Feedback 2: Ocean Circulation Feedback 3: Melting Permafrost
LESSON 5: REGIONAL EFFECTS OF CLIMATE CHANGE 40 minutes • Explain how climate change will cause droughts and floods from changing precipitation patterns combined with increased evaporation, more intense hurricanes fueled by warmer oceans, insect and disease outbreaks and other possible effects • Predict what might happen in a specific region	Region 1: Maldives Region 2: Norway Region 3: Iowa Region 4: Republic of Chad Region 5: Amazon basin Region 6: Southern California Impacts of Climate change
LESSON 6: WHAT NOW? 40 minutes • Brainstorm ideas of how to respond to climate change • Think critically about the trade-offs between different possible courses of actions	None

Lesson 1: Our Unique Atmosphere

How does our atmosphere keep the Earth warm?

Question	How does our atmosphere keep the earth warm?
Objective	Students will be able to explain how heat-trapping gases work in the atmosphere. Students will explain why carbon dioxide and other heat-trapping gases are necessary for life as we know it.
Time Needed	40 minutes
Materials	Reading 1: The Structure of the Atmosphere Reading 2: Heat-Trapping Gases in the Atmosphere Reading 3: The Greenhouse Effect

Directions:

WARM UP ACTIVITY

Have students count off from one to three. Each student must then find another student who has the same number. In these pairs, have the students cooperatively read the passage that corresponds to their number:

Reading 1: The Structure of the Atmosphere
Reading 2: Heat-Trapping Gases in the Atmosphere
Reading 3: The Greenhouse Effect

LESSON

1. Each pair then plans a way to teach their topic to other students. Their lesson will need to include an explanation of the major concepts in the passage and an explanation of the visuals that accompany the passage. Students will also need to include in their lesson an original analogy and an original visual that help explain the concepts in their passage.
2. Make sure students understand that an analogy is a comparison based on a similarity between two things that are otherwise dissimilar. For example, students who read the passage about the layers of the atmosphere could compare the layers of the atmosphere to the different colored layers on a Gobstopper candy or an onion or a layer cake. They would then draw a visual that helps clarify their analogy.
3. These pairs then split and each student finds another student who also has the same number. For example, a student with the number one will find a different student who is also a number one. These new pairs then share with each other the lesson they prepared with their first partner, including the analogy and original visual. These new partners give each other feedback on aspects of their lesson that were especially good. Each can then decide to incorporate certain aspects of the partner's lesson into his/her lesson to strengthen it.
4. Next, students find new groups that comprise a student with each number. For example, a student with the number one would find a student with the number two and also a student with the number three. Starting with the student with the number one, the students teach their lessons to the other two students in their group.
5. The teacher then picks one student from each group to share his or her analogy and visual with the class.

Notes to Teachers:

As the students are cooperatively reading, planning and practicing their lessons and presenting their lessons to each other, circulate between the groups and listen at each group for a few moments to gauge the progress of the groups and to make certain that students are focusing their efforts on the task.

Before dividing the students into groups, explain the entire activity to them and let them know how much time they will have for each section of the activity.

Explain to the students that you will be circulating between the groups during this activity and that you may ask any student at any time to explain any aspect of the passages. Let them know that it is the responsibility of each group to make sure that each group member understands all the concepts and would be ready to explain any of the topics.

Lesson 2: Emissions of Heat-Trapping Gases

How do heat-trapping gases affect our atmosphere?

Question	How do heat-trapping gases affect our atmosphere?
Objective	Students will be able to explain how increased atmospheric concentrations of heat-trapping gases warm the atmosphere. Students will be able to predict what will happen to global temperatures if atmospheric concentrations of heat-trapping gases increase. Students will be able to identify sources of heat-trapping emissions. Students will calculate their carbon footprint. Students will identify ways they can reduce their carbon footprint.
Time Needed	40 minutes
Materials	Image 1: Greenhouse – Green Planet Image 2: 1000 Years of Changes Image 3: Carbon Dioxide in the Atmosphere Handout 1: Energy Use in Your Home Handout 2: 20 Simple Steps to Reduce Climate Change Slideshow presentation available at: ***www.willstegerfoundation.org/curriculaextras***

Preparation:

Several days before you plan to teach this lesson, give students the question slips from Handout 1 so that they can find out the following information about their home and family energy use:

- How do you heat your house: electric, natural gas or heating oil?
- On average, how many miles a week do you ride in or drive a car?
- What is the average gas mileage of the cars you drive or in which you ride?
- On average, how much does your family spend on electricity each month?
- On average, how much does your family spend on natural gas each month?
- On average, how much does your family spend on heating oil each month?
- What percentage of recyclables does your family currently recycle?

Directions:

Ask students to recall from Lesson One how the Earth's atmosphere is structured, which atmospheric gases trap heat and how climate change works. Answers should cover the following information:

- When compared with the size of the Earth, the atmosphere is a relatively thin layer of gases.
- Based on temperature, the atmosphere is divided into four layers: the troposphere, stratosphere, mesosphere and thermosphere.
- Heat-trapping gases accumulate in the troposphere and include carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), water vapor (H_20) and chlorofluorocarbons (CFCs).
- The Earth absorbs energy from the sun and then re-emits that energy back towards space. Some of that energy is absorbed by heat-trapping gases and re-emitted back towards Earth. This is what some scientists refer to as the greenhouse effect.
- Heat-trapping gases make life as we know it possible on our planet. Without them, Earth would be a frozen wasteland with an average temperature of 0 degrees F (-18 degrees C). ***(5 min)***

Notes to Teachers:

Some students may have heard that climate change is "junk science" or that there is a big debate over whether or not it is really happening. You can let them know that there is no debate about whether or not increased levels of heat-trapping gases in the atmosphere will warm the planet. This is atmospheric physics. The only uncertainty lies in how much and how quickly the planet will warm.

Lesson 3: Communities of Living Things

How are different communities affected by climate change?

Question	How are different communities affected by climate change?
Objective	Students will be able to explain how changing weather patterns, a changing balance of competitors and changes in the availability of food and shelter can increase uncertainty for communities of living things. Students will be able to give examples of these uncertainties and disruptions from the Arctic communities. Students will predict how continued warming may affect communities of living things with which they are familiar.
Time Needed	40 minutes
Materials	Reading 1: Polar Bears Reading 2: Ice-edge Dwellers Reading 3: Land-Dwellers Reading 4: Plant Communities Reading 5: Human Communities

Directions:

Divide students into as many as five group with two-three students in each group depending on the number of students in the class. Give each group one of the readings about impacts of climate change on communities of living things (use scrap paper to print these if possible). If you have fewer than five groups, consider giving more than one set of passages to a group. ***(5 min)***

Reading 1: Polar Bears
Reading 2: Ice-edge Dwellers
Reading 3: Land-Dwellers
Reading 4: Plant Communities
Reading 5: Human Communities

Reource: Hassol, S. J., Correll, R., Prestrud, P., Weller, G., Anderson, P.A., Baldursson, S., et al. (2004). Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, England.

Have students take turns reading aloud sections of their passage to the rest of their group. ***(5 min)***

Next have each group discuss the impacts described in their passages and then plan a skit to illustrate these impacts. Skits should be a maximum of three minutes long. Groups will have very little time to plan their skits, so let them know in advance that skits do not need to be "polished." They should be impromptu, quickly moving and fun. ***(5 min)***

Have the entire class reconvene and have each group take turns presenting their skit. After each group's skit, one member of the group explains to the entire class the impact they were illustrating, including Arctic-specific examples from the passage. To allow for transition time between groups and for each group to explain the concepts in their skit, plan for five minutes for each group. ***(25 min)***

Homework:

Each student should write about a way in which continued climate change could affect a community of living things with which he or she is familiar.

Notes to Teachers:

- Before dividing the students into groups, explain the entire activity to them and let them know how much time they will have for each section of the activity.
- Circulate between the groups as the students are reading the passages to each other and planning and practicing their skits. Circulate between the groups and listen at each group to gauge their progress and to make certain that students are focusing their efforts on the task.
- Clearly set the expectation that skits should respect other members of the class and respect the living beings portrayed in the skits. Let students know that no inappropriate language, harassing or discriminatory content or explicitly sexual or violent portrayals will be tolerated.
- Monitor the time closely to ensure that all groups have time to present their skit. Give groups a two- and one-minute warming. Groups will have very little time to plan their skits, so let them know in advance that skits do not need to be "polished." They should be impromptu, quickly moving and fun.

Lesson 4: Implications of Warming in the Arctic

Why should we learn about climate change in the Arctic?

Question	Besides being a "canary in the coal mine," why should we learn about climate change in the Arctic?
Objective	Students will be able to explain feedback loops including surface reflectivity (albedo), ocean circulation, melting permafrost releasing heat-trapping gases and melting ice contributing to rising sea levels. Students will be able to explain how warming in the Arctic affects the rest of the world.
Time Needed	40 minutes
Materials	Feedback #1: Surface Reflectivity (Albedo) Feedback #2: Ocean Circulation (Thermohaline circulation) Feedback #3: Melting permafrost

Directions:

Explain to your students that the Arctic responds more quickly and more dramatically than the rest of the world to the early effects of climate change. In the past few decades, Arctic average temperature has risen almost twice as quickly as the average temperature in the rest of the world. This makes study of the Arctic interesting and important for several reasons including:

- Effects of climate change in the Arctic are easily recognizable and often dramatic.
- The Arctic supplies oil, gas and fish to the rest of the world and these supplies will be affected by climate change.
- Studying the Arctic can give us an early indication of the environmental and societal significance of climate change.
- Warming in the Arctic can impact the global climate and have other worldwide implications including sea-level rise.

Explain that one of the ways that Arctic warming can impact the global climate is through **feedback loops**. A positive feedback loop is a process that creates conditions that make that process quicken or intensify. A negative feedback loop is a process that creates conditions that make that process slow or diminish. Let students know that they are about to learn about three positive feedback loops in the Arctic that can affect the global climate. ***(5 min)***

Have students count off from one to three. Each student must then find another student who has the same number. In these pairs, the students cooperatively read the following passages:

Feedback #1: Surface Reflectivity (Albedo)
Feedback #2: Ocean Circulation (Thermohaline circulation)
Feedback #3: Melting permafrost
(5 min)

Then have each pair plan a way to teach their topic to other students. Their lesson will need to include an explanation of the major concepts in the passage and an explanation of the visuals that accompany the passage. ***(5 min)***

Lesson 5: Regional Effects of Climate Change

Though most dramatic in the Arctic, how is climate change affecting the rest of the world?

Question	Although we may see the effects of climate change most dramatically in the Arctic, what effects might we see in the rest of the world?
Objective	Students will be able to explain how climate change could cause droughts and floods from changing precipitation patterns combined with increased evaporation, more intense hurricanes fueled by warmer oceans, insect and disease outbreaks and other possible effects. Students will be able to predict what might happen in their region.
Time Needed	40 minutes
Materials	Region #1: Maldives Region #2: Norway Region #3: Iowa Region #4: The Republic of Chad Region #5: Amazon basin Region #6: Southern California Impacts of Climate Change

Directions:

Explain to students that climate change does not simply make the temperature a few degrees warmer all over the world. Climate change disrupts the climate, which includes precipitation, weather patterns and storms. This in turn affects plant, animal and insect communities, crops and the spread of disease.

Let students know that they are about to learn about potential regional effects of climate change. In groups they will read a description of the current climate and geographic location of a particular region of the world. They will have general information about how climate change can affect particular aspects of climate. They will then have to predict what might happen to the climate of that region as the Earth continues to warm. *(5 min)*

Divide students into groups of three. Each group will get a reading that has a description of the climate and geographic location of ONE of the following regions:

Region #1: Maldives
Region #2: Norway
Region #3: Iowa
Region #4: The Republic of Chad
Region #5: Amazon basin
Region #6: Southern California

Reference:

Central Intelligence Agency (2006). The World Fact Book. Retrieved on August 7, 2006 from https://www.cia.gov/cia/publications/factbook/index.html.

Lesson 6: What Now?

How can/should we as humans respond to climate change?

Question	How can/should we as humans respond to climate change?
Objective	Students will brainstorm ideas of how to respond to climate change. Students will think critically about the trade-offs between different possible courses of actions.
Time Needed	40 minutes
Materials	Internet access (for student preparation)

Preparation:

Several days in advance of teaching this lesson, ask your students to research (on the internet, in newspapers or magazines, through word-of-mouth or interviews) three different ways that people are working to solve or mitigate climate change-related issues. These examples can be personal, local, regional, national or international. Students should bring newspaper clippings, printed pages from the internet or a short written description of the action. Examples could be groups installing solar panels or wind turbines, groups coordinating carpools and bike commutes, groups planting trees, individuals installing compact fluorescent light bulbs or other energy-efficient measures, cities pledging to reduce emissions, regional or state targets for emission reduction, ideas for new laws being considered in Congress, international carbon-trading markets, etc.)

Directions:

Ask students to summarize what climate change is, what causes it and what some effects of it might be. Student answers should include:

- Our atmosphere has a natural ability to trap heat that would otherwise escape back into space. Without heat-trapping gases, temperatures would average around 0 degrees F and life as we know it would be impossible.
- Increasing concentrations of heat-trapping emissions are making the Earth increasingly warm. Human-caused sources of these emissions include land use change and burning of fossil fuels.
- As the Earth warms, sea levels will rise, there will be more droughts, floods, severe storms, disruptions to communities of living things and possible spread of disease. ***(5 min)***

Explain to your students that scientific evidence suggests that if atmospheric concentrations of heat-trapping gases stabilize at or below 544 parts per million (ppm CO2 equivalent), we have a good chance of holding global average temperature increases below 3.6 degrees fahrenheit (1.98 degrees celsius) from 1990 levels. This would avert the most severe impacts of climate change. Staying under the 544 ppm threshold would require cutting global emissions roughly in half from today's levels by mid-century. Given that the United States leads the world in both absolute and per capita emissions, we must achieve even deeper reductions here at home. Across the country, many U.S. states have already adopted 75-85 percent long-term reduction goals. To meet these aggressive emission reduction goals, we can draw on solution options that range from changing our personal actions, to local, state and national policies. Businesses can also play an important role through emission reduction commitments and investments in clean energy technologies.

Notes to Teachers:

- As the students are brainstorming and critiquing their ideas, circulate between the groups and listen at each group for a few moments to gauge the progress of the groups and to make certain that students are focusing their efforts on the task.
- Before dividing the students into groups, explain the entire activity to them and let them know how much time they will have for each section of the activity.
- Explain to the students that you will be circulating between the groups during this activity and that you may ask any student at any time to explain any of their ideas.
- The goal of the homework letter writing activity is to help students develop citizenship skills. The goal is not to force students to take an action in which they do not believe.