CLIMATE CHANGE

Climate Super Solutions

Lesson Set 5 of 5

NCSE National Center for Science Education

Teacher Prep

Age Levels: 9th-12th grade

Time Commitment: 8–9 days *(if all activities completed)*

Key Vocabulary/Concepts: community science, biodiversity, ecology, evolution, crowd-sourced, efficiency, simulation, carbon emission, carbon sequestration

Materials:

- Student-facing handouts for each activity
- Sticky notes
- Bird Identification Cards
- Binoculars, if participating in a bird count
- Nets, binoculars, bins/pans, and macro lenses, if participating in a biodiversity survey
- Project Drawdown Cards
- Blank paper
- Art supplies such as crayons, colored pencils, and markers

Apps and Software:

- Google Jamboard or Google Drawings
- Merlin Bird ID by Cornell Lab application
- eBird by Cornell Lab application
- Seek by iNaturalist application
- Presentation software such as Powerpoint, Canva, or Slides
- Design Our Climate by The King's Centre for Visualization in Science applet.

Introduction

This lesson set explores the role of non-scientists in climate change research as well as possible mitigation strategies for the future. Students are guided through a self-exploration of their experience as scientists and the discoveries being made with crowd-sourced data in regard to species' responses to climate change. Empowering students to engage with the scientific community in a real-world context translates into confidence to take action in order to counteract climate change. In a lesson set meant to infuse students with hope, students investigate the economic, social, and environmental impacts of climate solutions.

Teacher Goals

1) Provide structured opportunities for students to ask questions that drive the learning process.
2) Develop students' ability to analyze scientific papers in order to summarize their methods, findings, and conclusions.
3) Facilitate the development of students' identity as scientists, their use of scientific practices and skills, and their understanding of the nature of science.
4) Orchestrate student research and presentation of Project Drawdown solutions.

Student Learning Goals

1) Generate questions to clarify the potential solutions to climate change, their social and economic impacts, and the consequences of implementing these solutions.

Climate Change Lesson Set Series

https://ncse.ngo/supporting-teachers/classroom-resources

CLIMATE CHANGE

Student Learning Goals (continued)

2) Engage in a community science project relevant to a potential outcome of climate change and assess the impact of the project.
3) Analyze a scientific paper that uses crowdsourced data in order to explain how organisms are responding to climate change.
4) Obtain and communicate information about current solutions available to mitigate climate change and evaluate the effectiveness of these solutions.

Background

Teacher Knowledge

Nature of Science

We recommend that students work through the NCSE Nature of Science lesson sets prior to completing this lesson set. Part E: The Characteristics of Science Denial in Nature of Science Lesson Set 1: Science is a Way of Knowing is especially valuable. It takes students through several examples of FLICC in action while dismantling common misconceptions about the COVID-19 pandemic. However, if this is not possible, be sure to introduce students to FLICC, a framework for understanding science denial, prior to presenting this lesson set. Learn more about FLICC.

Scientific Concepts:

This lesson set focuses on climate change solutions. Students are more likely to partake in environmental action, including actions intended to mitigate climate change, if such goals are presented within a hopeful context. Solutions that students will research include energy-replacement and carbon-sequestering technologies. If a refresher on climate solutions is necessary, consider checking out the Paleontological Research Institute's Teacher-Friendly Guide to Climate Change or Jeffrey Bennett's online Global Warming Primer before introducing this curriculum to your students.

Discussion Points

- What does it mean to do science?
- How can non-scientists be a part of the scientific community?
- How much must our collective carbon emissions decrease in order to avoid the worst effects of climate change?
- What solutions already exist to avoid the worst effects of climate change?
- What must we do individually and collectively in order to combat Earth's dramatic climate change?
- What next steps am I willing to take in order to be a part of the climate solution?

Prerequisite Student Knowledge

Students should have a basic understanding of the causes and effects of anthropogenic climate change prior to starting this unit. We recommend students work through the prior NCSE Climate Change lesson sets prior to completing this lesson. Lesson Set 1: Scientific Consensus: A Tsunami of Evidence and Lesson Set 2: Understanding Climate Modeling are especially beneficial.

Core Misconceptions

MISCONCEPTION: ***Organisms (including humans) will adapt to a changing climate so no actions are required—nature will simply do its job.***

FACT: Given the current model predictions for the effects of climate change, many organisms are faced with three options – adapt, move, or die.

MISCONCEPTION: ***Countries have waited too long to combat climate change.***

FACT: Solutions are both possible and the responsibility of every human in every country moving forward.

MISCONCEPTION: ***Climate change cannot be stopped or slowed without crippling the economy.***

FACT: Current technologies are capable of mitigating climate change.

FACT: New innovations and emerging technologies to help reduce the human footprint and address societal problems are under constant development.

MISCONCEPTION: ***Alternative energy powers (like solar or wind) are enough to solve climate change.***

FACT: Multiple strategies, among them the use of alternative energy sources, are needed to reduce greenhouse emissions.

Teacher Instructions

Anchoring Phenomenon

Anchor: Science in Our Community

- Begin class by asking students to consider the following questions:
  - *What is science?*
  - *What does it mean to "do" science?*
- As students share their responses, respond with the following question: "*What makes you say that?*" This provides students with the opportunity to connect their response to their prior experience with science both inside and outside the classroom.
- Ask students to define the word "autobiography" and ask for examples of autobiographies they have read or heard of. Ask students to share what kind of information they may find in an autobiography and create a list of that information in a shared space, such as a whiteboard.
- Using the student-generated list, create expectations for students for their personal science autobiographies. Ask students to:
  - Summarize their science experience, including the first time they remember doing science.
  - Provide their definition of "science."
  - Describe how they envision themselves doing science in the future.
- After sufficient time, organize students into small groups and direct them to share their autobiographies with each other. Assign one student in each group as a note taker. The note taker should identify:
  - Common experiences between the students.
  - Questions students asked and their answers.
  - Unique experiences students included in their autobiographies.
- **Activity 1: Tweet About It**
  - Introduce students to birdwatching by showing the video Introduction to Birding | Birding 101 with Sheridan Alford (3:35).
  - Pass out the *Bird Identification Cards* and ask students to highlight any important information that might help them to identify these birds in the moment.
  - Review the *Bird Identification Four Square Student Handout* and demonstrate how to fill it out.
  - Ask students to consider the following questions in order to set expectations for the bird walk:
    - *What volume level is going to be appropriate for birding? Why?*
    - *What do you think is better: walking or standing still? Explain.*
    - *What amount of note taking is appropriate?*
  - Students should generally set the following expectations:
    - Students should be silent or speak in a whisper. This will encourage more activity from the birds and allow students to listen to their calls.
    - Some walking at a slow pace is appropriate, but most of this activity should be completed at a stand still. No running. This will avoid scaring the birds away.
    - The entire four-square should be completed. For each bird seen, its coloration, relative size, location, and activity should be recorded.

Anchoring Phenomenon (continued)

Anchor: Science in Our Community (continued)

- Using the *eBird Essentials for Educators*, complete a birding walk with your students. Upon completion, ask students to compare and contrast their findings and make any identifications possible.

- **Activity 2: The Butterfly Effect**
  - Show students the video "Why is biodiversity so important? – Kim Preshoff" (4:18) As students watch, ask them to consider the following questions:
    - *What is something that excites you?*
    - *What is something that surprises you?*
    - *What is something that worries you?*
    - *What do you think could be a next step?*
  - Share answers, focusing specifically on students' ideas for next steps.
  - Introduce the Seek by iNaturalist application. Ask students to consider the following questions in order to set expectations for their biodiversity survey:
    - *What volume level is going to be appropriate for this activity? Why?*
    - *What do you think is better: walking or standing still? Explain.*
    - *What amount of note taking is appropriate?*
  - Students should generally set the following expectations:
    - Students should be silent or speak in a whisper.
    - Some walking at a slow pace is appropriate, but most of this activity should be completed at a stand still. No running.
    - The entire four-square should be completed. For each organism seen, its coloration, relative size, location, and activity should be recorded.
  - Using the *iNaturalist Seek User Guide*, complete a biodiversity survey with your students. Upon completion, ask students to compare and contrast their findings and clarify any uncertain identifications.

Driving Question Board: Climate Super Solutions

- Provide students with the opportunity to reflect on their experience. Ask them to write their responses to the following questions:
  - *What kinds of science skills did you use during your birding or biodiversity inventory experience?*
  - *What kinds of questions could this survey work answer?*
  - *What kinds of problems could this survey work to solve?*
  - *Is this science?*
- Using the Driving Question Board, say, "*During this unit we will be asking the question: What is our role in combating climate change? On your Post-it notes, write two questions. One should be about our individual role in regards to combating climate change. The second should be directed towards the kinds of solutions that are now available or could be available in the future.*"

Anchoring Phenomenon (continued)

Driving Question Board: Climate Super Solutions (continued)

- Ask students to place their Post-it Notes on the Driving Question Board. Repeat that questions are okay! After class, reorganize the board, grouping similar questions together. This board will be utilized regularly throughout the unit.
- **Important:** At the end of each part of this lesson set, project the lesson set's Driving Question Board. Identify any of the questions students asked that have been answered by this activity. Ask students to provide the answers to these questions and prompt students for new questions.
- **Teacher Tip:** It may not be possible, depending on the amount of time available to dedicate to the Anchoring Phenomenon, to complete both Activity 1: Tweet About It and Activity 2: The Butterfly Effect. If you cannot complete both activities, choose the one that forms a stronger connection to your location or will resonate more with your students.

Storyline Activities

Part A: What is...?

- Start class by showing the video "Why I Became a Biologist – Camille Parmesan" (2:00). As students are watching the video, they should consider the following questions:
  - *Prior to becoming a scientist, what kind of experiences did Parmesan have with science?*
  - *How does Parmesan's work as a scientist compare to "what people think of as a scientist"? Is she any more or less of a scientist than a research scientist is?*
  - *How does the birdwatching or biodiversity inventory completed in the Anchor activity compare to Parmesan's work*?
- Organize students into groups and pass out the excerpts from *Ecological and Evolutionary Responses to Recent Climate Change* by Camille Parmesan and the *Fact Triangle Student Handout*. Provide students with enough time to read their excerpt, identify its main idea, cite supporting evidence, and develop questions. Actively monitor student activity and provide support where necessary.
- While student groups are sharing their results, all students should be considering the common strands between the sections of the paper. Record any commonalities students identify.
- Ask students to identify how crowd-sourced data would have helped this research.
- Keeping the same groups or organizing students into new groups, assign each group to one of the scientific papers in the *Scientific Papers Using Crowd-Sourced Data* folder in the Teacher Resources Folder above. Students will read their assigned paper and create a presentation to share with the class. Students should use the *Data Dash Rubric Student Handout* to complete the review of their papers. Once they have gathered the information necessary, students should create a PowerPoint slide and practice presenting their review, which should last between one and two minutes, while still meeting the guidelines of the rubric.

Storyline Activities (continued)

Part A: What is...? (continued)

- **Activity Variation:** Instead of completing a Data Dash using the *Data Dash Rubric Student Handout*, provide students with the *Scientific Paper Four Square Student Handout*. Using this handout, students read their assigned scientific paper, then complete the four square with the claim, evidence that supports the claim, connections to climate change, and use of the crowd-sourced data. Finally students make connections to Dr. Parmesan's research.
- **Teacher Tip:** Explain to students that it is possible to divide and conquer the work if each student reads the paper looking for a different aspect of the rubric.
- Set aside time for students to present their reviews to the class.
- **Anchor to Activity – Tying it All Together:** After presentations are complete, give students time to reflect on how crowd-sourced information was used in the papers. *Would this research have been as effective without the use of crowd-sourced data? What flaws could occur with this data? How does this connect to what Parmesan does?*

Part B: What if...

- Begin this lesson by showing the video "Climate change: Earth's giant game of Tetris – Joss Fong" (2:48). As students are watching the video, ask them to consider the following questions:
  - *How is the information connected to what you already knew?*
  - *What new ideas did you get that extended your thinking?*
  - *What questions emerge for you?*
- Provide students with the *What If... Student Handout* and introduce The King's Centre for Visualization in Science applet "Design Our Climate." Read the introduction together as a class and provide students with a few minutes to explore the simulation on their own to better understand its functionality. Ask students to share their discoveries with the class, then set expectations for completing the handout.
- Organize students into groups and provide time to complete the simulation. After sufficient time, complete a variation of a jigsaw:
  - All but one student in each group will visit a different group. No two students from one group should visit the same group. During this time, they will learn about their new group's results from the Design Our Climate simulation.
  - Each group should select one person to stay at their table or desk. This person will share the group's work with visiting students. They should be willing to answer questions.
  - All students will return to their original group and use the idea from the visit to revise their stabilization wedge.
- **Anchor to Activity – Tying it All Together:** Revisit the idea of "doing science." *What place do simulations and models have in science? When might a scientist use a simulation? Are simulations free from human bias or error?*

Storyline Activities (continued)

Part C: What Now?

- Pass out the first set of *Project Drawdown Cards* (blue set). Tell students that these are four ways we could decrease carbon emissions in our day-to-day transportation between now and 2050. Ask them to organize the cards in order of which they think will have a greater impact in decreasing carbon emissions in the next 25 years. After a moment, ask students to share their responses, then project the answers.
- Pass out the second set of *Project Drawdown Cards* (green set). Tell students that these are four ways we could decrease carbon emissions based on the way we grow and use food between now and 2050. Ask them to organize the cards in order of which they think will have a greater impact in decreasing carbon emissions in the next 25 years. After a moment, ask students to share their responses, then project the answers.
- Pass out the last set of *Project Drawdown Cards* (gold set). Tell students that these are four ways we could decrease carbon emissions in our buildings and homes between now and 2050. Ask them to organize the cards in order of which they think will have the greater impact in decreasing carbon emissions in the next 25 years. After a moment, ask students to share their responses, then project the answers.
- As you collect the cards, ask students to reflect on this exercise using the following questions:
  - *How is the information connected to what you already knew?*
  - *What new ideas did you get that extended your thinking?*
  - *What questions emerge for you?*
- *Important Note: The answer key for the Project Drawdown Cards can be found in the Teacher Resource Folder.*
- Show students the Project Drawdown website and inform them that this website was used to gather information to create the cards. Each solution proposed has been reviewed for its potential impact on reducing carbon emissions as well as the cost of implementation. Pass out the *Project Drawdown Poster Rubric*. Students will research one of the solutions from the Project Drawdown website and present their solution to the class.
- **Teacher Tip:** Students may be interested in learning more about which solution might have the most impact in their community. Ask students to research the local impact of these solutions. For example, students could examine the electricity usage in their school and develop a plan to retrofit the school with better insulation, convert to all LED light bulbs, or install high-performance glass in the windows. With this information, students could approach their local school board or district with a request to make this change.

Storyline Activities (continued)

Part D: What Next?

- Ask students to take out their science autobiographies that they wrote for the Anchor activity. Ask students to reflect on what they thought their science experience was. Has their understanding of science changed? Ask students to revise their science autobiographies to contain an action they didn't previously think was "doing" science or to include an action they'd like to take in the future.
- Complete one of the two activities outlined below. Choose what works best for your classroom, timeframe, and resource availability.
- **Activity 1: Community Science in Action**
  - Using the list of community science projects provided in the Teacher Resource Folder or a community science project you are familiar with, provide students with an opportunity to engage with community science. This may include revisiting the bird count or biodiversity inventory from the Anchor activity. However, it is important to draw direct connections between the community project chosen and climate change research.
  - After completing the project, ask students to reflect on their experience using the following questions:
    - *What kind of impact do you think we had?*
    - *What kind of research might be done using our data?*
    - *What community science projects would you complete moving forward?*
- **Activity 2: Super Solutions in Action**
  - Ask students to reflect on their understanding of climate and climate change. To prompt their thinking, ask them to describe the negative effects climate change will have in the future. Possible responses include:
    - Sea level rise
    - More frequent and intense extreme weather events
    - Thawing permafrost
    - Shrinking glaciers
    - Ocean acidification
    - Coral bleaching
  - Remind students that this future is a potential future. Ask them to describe the research they did using Project Drawdown. To prompt their reflection, use the following questions:
    - *What are the potential positive outcomes of a particular way of mitigating climate change?*
    - *What other benefits might this solution have to society, the economy, or the environment?*
  - Provide students with the *Climate Change Outcomes Comic Strip Rubric*. Read the introduction with students and set expectations for their work. Students will create two comic strips. One comic strip will answer the question "What if nothing is done to avert a climate disaster?" The second comic strip will answer the question, "What if we use _____ (fill in the blank) and other Project Drawdown solutions?"

Storyline Activities (continued)

Part D: What Next (continued)

- **Anchor to Activity – Tying it All Together:** Provide students with the opportunity to go back to the original questions they asked that are listed on the Driving Question Board. Give time for students to reflect on what their question was, what they learned related to their question, and what new questions they have. Prompt students to think about how scientists might learn the answers to these questions or how they might go about researching it themselves.
- **Teacher Tip:** It is important to give students time to reflect on what next steps they are willing to take in order to avert a climate crisis. Ask students to choose one meaningful action they could take. Use the following questions to guide students through this reflection:
  - *What excites you about the action you've chosen? What's the upside?*
  - *What do you find worrisome about the action you've chosen? What's the downside?*
  - *What else do you need to know? What additional information would help you to take the next step?*
  - *What is the next step in moving forward with this idea?*

Extension Activities

Deeper Dive

- Deeper Dive
  - Schools for Climate Action
  - Optimal and Sustainable: Renewable Energy Revamp
  - The Solutions Project
  - Net-Zero America: Potential Pathways, Infrastructure, and Impacts

Online Resources

» Nature on PBS video: Introduction to Birding | Birding 101 with Sheridan Alford (3:35)
» Ted-Ed video: "Why is biodiversity so important? – Kim Preshoff" (4:18)
» University of Texas at Austin Environmental Science Institute video: "Why I Became a Biologist — Camille Parmesan" (2:00)
» Ted-Ed video:"Climate change: Earth's giant game of Tetris – Joss Fong" (2:48)

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