

Exploring Climate Change through Students' Place Connections and Public Data Sets

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Abstract

Climate change is a pressing societal challenge. It is also a pedagogical challenge: It is a global phenomenon, but its local impacts manifest differently from place to place. It is an issue of global equity and social justice, given that those communities which have contributed most to emissions have greater economic resources to shelter themselves from its consequences, while the lowest emitters are most vulnerable. It is scientifically complex, and at the same time it evokes deep emotions. These overlapping issues call for new ways of science teaching that center personal, social, emotional, and historical dimensions of the crisis. In this article, we describe a middle school science curriculum approach that centers students' own "special places" as a first step toward examining the global causes and impacts of climate change with large scale public data sets. This approach invites students to explore datasets about climate change and author their own data stories about climate change impacts and inequities by blending data and narrative texts. In doing so, students learn about climate change in ways that engage their personal and cultural connections to place, engage with complex causal relationships across multiple variables, time and space, and voice their concerns and hopes for our climate futures. Connections to relevant science, data science and literacy standards are outlined, along with relevant data sets and assessments.

Introduction

Climate change is a pressing societal challenge, calling for new ways of teaching that center personal, social, emotional, and historical dimensions. It entails teaching that engages with the causes and effects of climate change on multiple scales, encompassing local, regional and global interactions and impacts. It also requires attention to the underlying inequities of the crisis based on race, class and geographic location (Bigelow, 2018). Such teaching requires educators to work with, not against, emotion such as hope, despair and anger (Lombardi & Sinatra, 2013; Ojala, 2012). Importantly, positioning students as authors and advocates for collective change, rather than receivers of information, is one step in this direction. As an

interdisciplinary socio-ecological crisis, teaching about climate change necessitates integrating multiple disciplines.

Our work focuses on students *writing data stories* as a generative approach to bridge students' personal experiences of socioscientific issues with broader explorations in science, data science, and literacy. In drafting a data story, students draw on their personal narratives, as well as those of others, to motivate analyzing, interpreting and communicating data. In situating their personal stories within larger datasets and global contexts, students learn how data and personal experience can be woven together to better understand the past and depict the present, as well as to imagine and enact more just futures (Gutiérrez et al., 2019). Existing research has shown how working with data in ways that intertwine narrative texts, storytelling and personal connection can support holistic and conceptually-rich learning across disciplines and contexts (Author et al, 2021; Kahn, 2020; Author, 2022).

In this article, we share an approach to climate change education that centers students' "special places" as a way to connect personal and specific experiences of climate change with the global patterns and understandings highlighted by the *Next Generation Science Standards*. We describe a multi-week curriculum that supported middle school students in exploring how climate change manifests in their self-identified "special places," learning about climate activism around the world, and locating their "special places" collectively within global datasets to understand the inequitable causes and impacts of climate change. Students author their own data-based stories about these investigations using computational data analysis tools and large scale public data sets on carbon emissions, temperature, and poverty.

Framework

We begin by highlighting several principles that guided our curricular design and can be useful in teachers' own planning and teaching. Together, these principles show how "special places" can be leveraged to center young people as inquirers and advocates as they integrate data, personal experience, and broader youth voices into their own understandings of climate change, climate inequities, and climate futures. While valuable to all students, these principles have been developed with special attention to supporting multilingual learners (MLL) by integrating sociocritical literacy practices such as storytelling into scientific inquiry (Gutiérrez, 2008; Gutiérrez et al, 2019).

- Principle 1: Center studies of climate change within **broader youth-led movements**, at local and global scales, to elevate inequities alongside possibilities for collective action.
- Principle 2: Elevate **personal connections, relationships and histories with specific places** to ground studies of climate change in multiple meaningful cultural and localized contexts.

Principle 3: Leverage the **multiplicity and diversity of students' place connections** to

- elevate the simultaneously local/diverse and global/unjust dimensions of climate change, its causes, and its impacts.
- Principle 4: Enable **narrative forms of data interpretation**, analysis and communication, working with large public data sets to explain the what and why of their stories.

Curriculum Materials and Approach

“Exploring Climate through Data and a Special Place” is a multi-week science curriculum unit designed for middle grades students. At the broadest level, it is presented as an investigation with the driving questions, *“How are people affected differently by climate change? What does this look like in places I care about?”* (see Figure 1). Students are prepared to approach these questions in three phases starting with learning about youth-led climate action and connecting to **personal** exploration of how a changing climate is affecting places the student cares about, moving to explorations of **data** to highlight global causes and vulnerabilities to climate change, and concluding with the construction of data stories intended to inspire **action**. We describe each phase in detail, highlighting how the design principles described above were translated into lessons, teaching practices, and opportunities for student reasoning supported by a 5E progression. Our curriculum materials and data sets are publicly-available and bilingual (Spanish/English). This dual access to multiple languages in science classroom text, data, and discourse has been shown to support multilingual students’ science disciplinary engagement (Suárez, 2020).

Personal: Engaging and Connecting Climate to Students’ Special Places (5E: Engage)

In this phase (4 class sessions, 50 minutes each), students begin by reading and reflecting on youth climate action videos and Photovoice projects (Wang & Burris, 1997), written by local and globally located youth. Students then create their own Photovoice individually for a place that is special to them and examine, through journalistic research and interviews with family members and others, how climate change is impacting this place. The focus of these four lessons centers on the following climate questions: *How do youth climate activists use feelings, message, evidence and audience? What are my initial observations about the effects of climate change in my special place?*

In the first lesson, students brainstorm what feelings, concerns and questions they have about climate change in small groups. They select a “special place” anywhere in the world to study in depth, writing about it with the support of sentence stems. They are also invited to interview their friends and family — ideally, who live or have lived in their special place — to explore the specific impacts of climate change on that place. In the second lesson, students learn about other youth engaged in climate change advocacy in their communities. They watch videos of two young people who are respectively located locally and globally. After each youth climate activist video, the teacher asks students in small groups to reflect on how the video

made them feel, what was the core message, who is the audience, and why was climate change important to the young person.

In the third lesson, students are introduced to a literacy form commonly used in community science communication, [Photovoice](#). Photovoice involves juxtaposing photographs, images and text to communicate the author's perspective on an issue that is impacting their lives and to advocate for change with key stakeholders. Students explore example Photovoice texts about how climate is impacting specific locations globally. They then create their own Photovoice project using a photograph they bring or find of their own special places, focusing on the five core prompts (see Figure 2 for an example about impacts of climate change on corn crops in a Guatemalan community, and the five Photovoice questions). Students then share their special place Photovoice projects, marking each special place described on a global map to document the diversity of locations and impacts across the classes' special places (see Supplemental Materials section for supporting materials in lessons 1-3).

In the fourth lesson, students are introduced to *writing data stories* as a way to combine personal stories with scientific and data argumentation. The teacher introduces students to an example data story about a place special to them (see Figure 3 for a model data story about extreme weather in Cuba, constructed by a member of our research team). This introduction intentionally shows how photographs can be combined with data tables and graphs to holistically communicate the emotional, scientific, local and global dimensions of climate change.

Data: Exploring the Causes and Impacts of Climate Change (5E: Explore and Explain)

In this next phase (6 class sessions, 50 minutes each), student pairs explore data tables, maps and graphs of country-by-country CO₂ emissions, mean yearly temperature change, and poverty rates. Using these datasets and the Common Online Data Analysis Platform (CODAP), they explore the questions, *Who is most responsible for climate change?*, *Who is most vulnerable to climate change?* And, *What does this mean for my special place?* As a web-based, free data platform, CODAP enables students in grades 6-12 to analyze, interpret and communicate with data by flexibly moving between data in tabular, graphical, and geospatial maps. One feature of CODAP that allows students to bridge the personal/local and collective/global dimensions of this investigation is the ability to highlight specific data points across these different representations (Figure 4). For example, a student can highlight the country corresponding to their specific special place on the map, exploring the country's temperature anomalies, CO₂ emissions, and poverty levels. Students in a group can use this feature to then easily compare their special places, or to investigate larger regions of interest within the global dataset.

In the first lesson, students work in pairs to explore carbon emissions data, examining patterns across geographies and locating their special places within the map. Starting with the

initial choropleth data maps of worldwide Co2 emissions per person (Figure 5), students explore the question “*Who is most responsible for climate change?*” The teacher begins this exploration with a notice/wonder cycle (“What do you notice? What do you wonder?”, see NCTM resources in Online Resources), asking pairs of students to examine and share their observations from the data map and to connect these observations to what they know about the relationship between CO2 emissions and climate change. Over the course of two days, students work to identify the largest emitters of CO2, and to examine emissions data for their own special places and those of their peers. These data explorations are supported by an introduction video about data table, graph and map functionalities (see Online Resources for additional CODAP introduction materials).

Students are also supported to formulate their own questions within the data sets, with prompts such as “What are you curious about? What data will be useful to you and Do you think a map and/ or graph will be helpful to answer your questions?.” In the next lessons, students are encouraged to continue to explore the data tables, maps and graphs to answer the question, “*Who is most vulnerable to climate change?*” Here, students continue their global focus, this time exploring country-by-country level data about poverty rates and temperature anomalies as different indicators of climate vulnerability. As with carbon emissions, students are encouraged to consider inequities in vulnerability on both the local and global scale through the lens of their special places. After these class lessons visualizing and analyzing the data using spatial choropleth maps, dot plot graphs, and raw data tables, students then spend time brainstorming and storyboarding their own data story, focusing on location, message and audience as they begin linking together their insights from analyzing and interpreting data.

Action: Writing Data Stories and Inspiring Action (5E: Elaborate and Evaluate)

In this phase (6 class sessions, 50 minutes each), students work with the qualitative and quantitative data that they had assembled thus far to author their own data story, pursuing the question: *Who do we want to talk to? What information do we want to share? How can we do something about climate change?* They are prompted to identify a specific target audience (e.g. youth, policymakers, teachers, the public) and to consider what types of stories and evidence would be most effective to inspire or motivate their audience to act around climate change. They revisit the example data stories shared earlier in the unit, analyzing these examples with an eye toward these decisions around audience, evidence, and story. Prompts and graphic organizers further encourage students to focus on how they can leverage their personal stories, “special places,” and broader data investigations to communicate their findings and inspire their audience to action. Figure 5, for example, structures students’ final presentations around the questions, *Why is your story important? What data do you have and what does it show/explain? And, What are your suggestions for change? What would you like your particular audience to do?* The last 3-4 days of the unit are reserved for students to present their data

stories, and those stories are assessed by peers and teachers using a rubric aligned with these questions (see Figure 7).

Conclusion

In this article, we have outlined framework principles and a 5E curriculum progression that sought to support climate change learning attending to the personal, social, emotional, and historical dimensions. As science educators and curricular designers seek ways to meaningfully teach about climate change, it is key to support interdisciplinary approaches such as those described here. Such approaches center the personal connections and relationships with special places alongside global understandings of the causes and inequities involved in the crisis. At the same time, it will also be key for students to engage with existing public data sets in ways that capture the multiple dimensions of climate change, where they can not only understand what *is* but also imagine and advocate for what *could be*.

Acknowledgements

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needs assessment. *Health Education & Behavior: The Official Publication of the Society for Public Health Education*, 24(3), 369–387.

Online Resources

- Common Online Data Analysis Platform (CODAP): <https://codap.concord.org>
- Teaching with CODAP Resources: <https://codap.concord.org/for-educators/>
- [Notice and Wonder Questioning Routines \(NCTM\)](#)
- [How to/Community PhotoVoice Tool Kits \(open source\)](#)

Supplemental Materials (links removed for blinded review when relevant)

- Writing Data Stories Climate Unit Google Slides (link removed)
- Curriculum Material Supports: Describing Your Special Place, Talking with your Family about Your Special Place, PhotoVoice Questions, Data Patterns in Climate Change ([link to note sheets](#))
- Examples of 3 Phases Worksheets
 - PhotoVoice Examples (see Figure 8)
 - Special Places and Data Patterns Examples (see Figure 9)
 - Data Story (see Figure 3)
- Public Climate Data Sets in Spanish: (Link removed for review)
- Public Climate Data Sets in English: (Link removed for review)
- Youth-led Climate Action Resources: (link removed fro review)

REQUIRED ADDITIONAL TEXT

Information for Call Out Box (Side Panel)

Content Area: Earth Systems

Grade Level: 6-8th grade

Big Idea/Unit: Human-produced carbon emissions are driving climate change, with inequitable impacts locally and globally

Essential Pre-existing knowledge: Personal experiences with climate change, understanding climate versus weather

Time Required: 12 class periods (50 minutes each)

Costs (for a class of 30): No costs (if laptop computers with web access available)

Basic Safety Requirements: No safety concerns

NGSS Table

Connecting to the Next Generation Science Standards (NGSS Lead States 2013)

<p>Standard</p> <p>MS-ESS3-5. Earth Systems. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the last century.</p> <p>https://www.nextgenscience.org/pe/ms-ess3-5-earth-and-human-activity</p>	<p>The chart below makes one set of connections between the instruction outlined in this article and the NGSS. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities.</p> <table border="1"><thead><tr><th>Dimensions</th><th>Classroom Connections</th></tr></thead><tbody><tr><td><p>Science and Engineering Practices</p><p>Analyzing and Interpreting Data</p><p>Use graphical displays (e.g. maps, charts, graphs, and/or tables) or large data sets to identify temporal and spatial relationships</p><p>Obtaining, Evaluating and Communicating Information.</p></td><td><p>Students analyze and interpret climate change related data, including carbon emissions, temperature and poverty data per capita in public global data sets</p><p>Students explore and select varying forms of information, to communicate how their special place is impacted by and implicated in climate change</p></td></tr><tr><td><p>Disciplinary Core Ideas</p><p>ESS3.D. Human activities, such as the release of greenhouse gasses from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding human behavior and applying that knowledge wisely in decisions and activities.</p></td><td><p>Students use and analyze patterns in their climate change data (as well as additional data source) to understand inequitable causes and impacts of climate change.</p><p>Students focus on places of particular vulnerability to climate change and contrast those with places emitted the highest carbon emissions per capita.</p></td></tr></tbody></table>	Dimensions	Classroom Connections	<p>Science and Engineering Practices</p> <p>Analyzing and Interpreting Data</p> <p>Use graphical displays (e.g. maps, charts, graphs, and/or tables) or large data sets to identify temporal and spatial relationships</p> <p>Obtaining, Evaluating and Communicating Information.</p>	<p>Students analyze and interpret climate change related data, including carbon emissions, temperature and poverty data per capita in public global data sets</p> <p>Students explore and select varying forms of information, to communicate how their special place is impacted by and implicated in climate change</p>	<p>Disciplinary Core Ideas</p> <p>ESS3.D. Human activities, such as the release of greenhouse gasses from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding human behavior and applying that knowledge wisely in decisions and activities.</p>	<p>Students use and analyze patterns in their climate change data (as well as additional data source) to understand inequitable causes and impacts of climate change.</p> <p>Students focus on places of particular vulnerability to climate change and contrast those with places emitted the highest carbon emissions per capita.</p>
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<p>Crosscutting Concepts</p> <p>Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.</p> <p>Cause and Effect. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.</p>	<p>Students create and interpret graphs, maps, charts and images, to be used to identify patterns in data</p> <p>Students contrast public data sets of carbon emission, temperature and poverty to understand inequitable causes and impacts of climate change</p>
<p><i>Building Towards Performance Expectation (PE listing with Clarification Statement and Assessment Boundary)</i></p> <p>MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]</p>	

Connections to the *Common Core State Standards* (NGAC and CCSSO 2010)

<p>ELA</p> <p>RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-5)</p>	
<p>WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ESS3-3)</p>	
<p>WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS3-3)</p>	

Mathematics

MP.2 Reason abstractly and quantitatively. (MS-ESS3-5)

7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-5)

ADDITIONAL RESOURCES SECTION

Principles and Enactment in “Exploring Climate through Data and a Special Place” Curriculum

Principles	Principle 1: Center studies of climate change within broader youth-lead movements, at local and global scales, to elevate inequities alongside possibilities for collective action	Principle 2: Elevate personal connections, relationships and histories with specific places to ground studies of climate change in multiple meaningful cultural and localized contexts.	Principle 3: Leverage the multiplicity and diversity of students' place connections to elevate the simultaneously local/diverse and global/unjust dimensions of climate change, its causes, and its impacts.	Principle 4: Enable narrative forms of data interpretation, analysis and communication, working with large public data sets to explain the what and why of their stories.
Activity Supporting Enactment	Watch and analyze youth climate action videos Author and present their own data story about climate and place, supporting narration and advocacy around climate injustices	Select and study a place special to students Interview family about place and climate histories and meaning Author photovoice about special place Anchor data and narrative inquiry and expression around a place special to youth	Youth-led activist video and Photovoice examples reflect multiple geographic locations and life stories Open choice of special places by youth, making visible multiplicity of locations, connections and impacts	Students author narrative response to climate change, with Photovoice and then Data Story Presentation

Embedded Assessment Across Three Phases

Lesson Student Work Product Slide link	Task Prompts	Description of type of assessment and any rubric categories
Unit Part A <i>Personal: Engaging and Connecting Climate to Students' Special Places (5E: Engage)</i>		
Lesson A4: Photovoice Slide 36	<p>Prompt: Answer 5 questions about their special place and include a photo that is linked to their special place.</p> <p>What do we SEE here? What is really HAPPENING here? How does this relate to OUR lives? Why does this situation EXIST? What can we DO about it?</p>	<p>Rubric</p> <p>Categories</p> <ul style="list-style-type: none"> *Climate change effects *Making connects *Writing and image
Lesson A4: Exit Ticket Effects of climate change Slide 41 A4: Handout	<p>Prompts:</p> <ol style="list-style-type: none"> 1) From my initial observations, I think climate change is affecting my special by ... 2) Additional evidence about climate change effects could include ... 	<p>Formative Assessment</p> <p>This is an assessment to check that students understand and identify the correct types of effects of climate change in their special place. This prompt and response indicates whether they are understanding how climate change is affecting different parts of the world.</p>
Unit Part B <i>Data: Exploring the Causes and Impacts of Climate Change (5E: Explore and Explain)</i>		
Lesson B5: Do Now Data and maps about climate change Slide 46	<p>Prompts:</p> <p>How do we use data to learn about climate change? What do you observe about the map? What does this map show?</p>	<p>Formative Assessment</p> <p>The Do Now is a formative assessment that helps the teacher identify students' existing knowledge about how to read maps so that the teacher can adapt to students' strengths and weaknesses in the following lessons.</p>
Lesson B6 Exit ticket Patterns in Carbon Emission Data Slide 67	<p>Exit ticket prompt: A pattern happens multiple times in similar ways.</p> <p>Patterns often show how things are similar, different, change or cause other things to happen.</p> <p><i>Describe one pattern you noticed in the carbon emissions for your special place. Why do you think there is that pattern?</i></p>	<p>Rubric Assessment</p> <p>Example of highest level of achievement:</p> <ul style="list-style-type: none"> *Understand what a pattern is [or refers to data but does not identify a clear pattern] *Pattern is based on correctly reading carbon emissions data visualizations [or partially/incorrectly reads data visualizations] *The pattern is well connected to their special place [or refers to data but does not connect it to special place] *The pattern identified was based on using three data visualization; [or uses two; only relied on one data visualization]
Lesson B6 Thinking about broader patterns <u>Last HW handout in this google doc</u>	<p>Prompt: "Now, think about a pattern you've seen, felt, or heard related to climate change. What is the pattern? What do you think is causing the pattern to happen? "</p>	<p>Formative Assessment</p> <p>This HW assignment helps the teacher know whether students can think about climate change causal effects and whether they can think more broadly outside their special place. It allows the teacher to adjust instruction as needed.</p>

Lesson B7 Station Notes Sheet Slide 74	<p>Prompt: Looking at the title, key, and colors /I think this map shows, / <i>Looking at the world</i> /I wonder ... <i>Looking at my special place</i> I wonder ...</p>	<p>Formative Assessment</p> <p>This provides another opportunity to check that students can do the very important task of reading data visualizations..</p>
Lesson 8.1 Data Investigation Questions Slide 78	<p>Prompt: Think about the data you can use in CODAP: CO2 emissions, water, temperature, or poverty. With your partner, think of a question you would like to explore about climate change in your special places or the world using the data. What is your question? Circle which of the following data you will use: <i>CO2 emissions, water, temperature, and/or poverty</i> Do you think you will need to make a map or a graph to answer your questions? What do you predict the data <i>will</i> show? After your investigation, describe what the data showed:</p>	<p>Rubric Assessment</p> <p>Describes highest level): *asks an well developed scientific question related to climate change *question can be answered by the data available and data selected by student *selects more than one type of data visualization to answer their question *effectively interprets and connects all the data used</p>
Lesson B8.3 Story Brainstorm Slide 91	<p>Use this to keep track of the things you learn while you explore data about your special place. For special place I see: (sketch image, graph, or pattern in the data) This shows: This is important because:</p>	<p>Formative Assessment</p> <p>This helps the teacher ensure students are on track to interpret, analyze, and use data for their CODAP data stories.</p>
Unit Part C <i>Data: Exploring the Causes and Impacts of Climate Change (5E: Explore and Explain)</i>		
Lesson C10 Final CODAP organizing Slide 107	<p>Prompt: -Open CODAP -Use your brainstorm and guidelines for writing a narrative to help you make decisions for organizing CODAP data -Decide a order for your data (photos, text, graphs, maps) to best tell your story</p>	<p>Rubric Assessment Attached</p> <p>Rubric categories *Data Analysis *Elements of a Data Story *Evidence based argument *Audience and message</p>
Lesson C10 Data Story Narrative Argument Slide 104	<p>Prompt: Each group will write a 3 paragraph narrative argument The narrative argument tells a message to an audience to inspire them to take action to change a problem You will use the data you collected in CODAP to support your argument. Each paragraph will have at least 5 sentences.</p> <p>These are the prompts for what to write in each of the three paragraphs:</p> <p>1: Why is your story important? 2: What data do you have? What does it show/explain? 3: What are your suggestions for change? Why are you speaking to this particular audience? What would you like them to do?</p>	<p>Rubric for Data Story Narrative Argument</p> <p>See Figure 7</p>
Lesson C11.1 Presentation Rubric for Data Story Slide 114		<p>Presentation Rubric (Student to Student)</p>

Separate File for Images

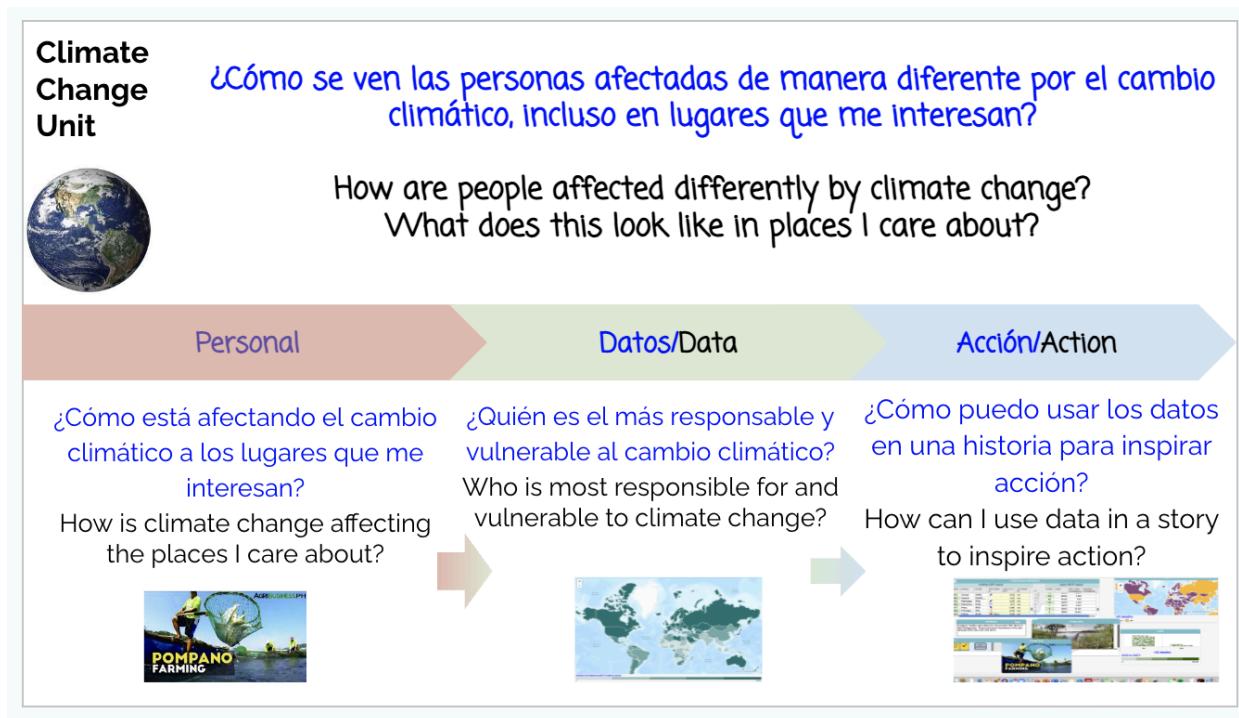


Figure 1. Slide from Lesson 1, providing an overview for students of the curricular unit's purpose and progression



Photovoice Example

What do we see here? Corn in the community of Rabinal Guatemala is brown and dying.



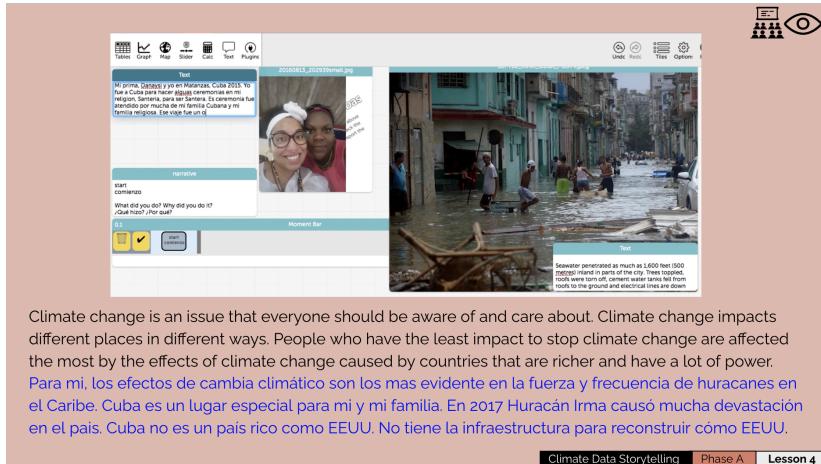
What is really happening? Climate change has been affecting this community. Because of climate change, the community is experiencing drought. They are losing their corn, and corn is a sacred crop. It is what people in this community use to make their tortillas, which they eat with every meal.

How does this relate to our lives? Students at our school have family in Guatemala, or other parts of central America. We are all part of the same human family, so what affects people in Guatemala affects us too.

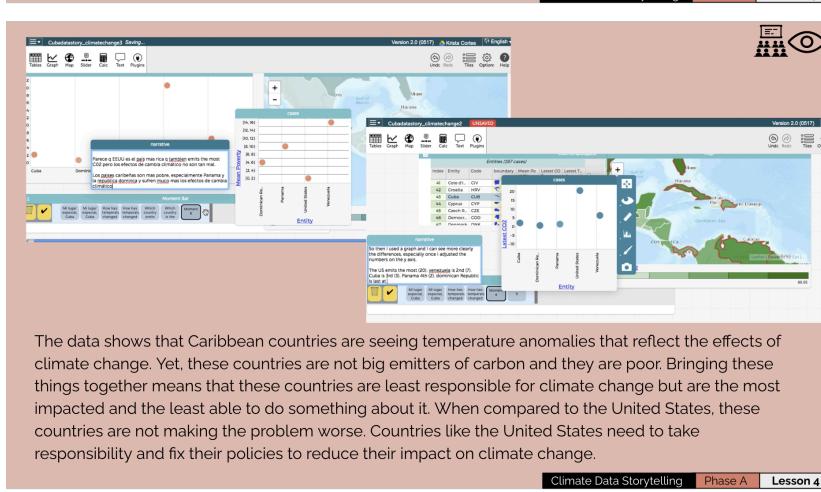
Why does this situation Exist? Many countries -- the United States especially -- have been polluting the environment by releasing greenhouse gasses into the atmosphere. This causes global warming, which causes drought in Guatemala.

What can we do about it? We can all do our part. We need to tell businesses that pollute about the consequences of their actions for people all over the world

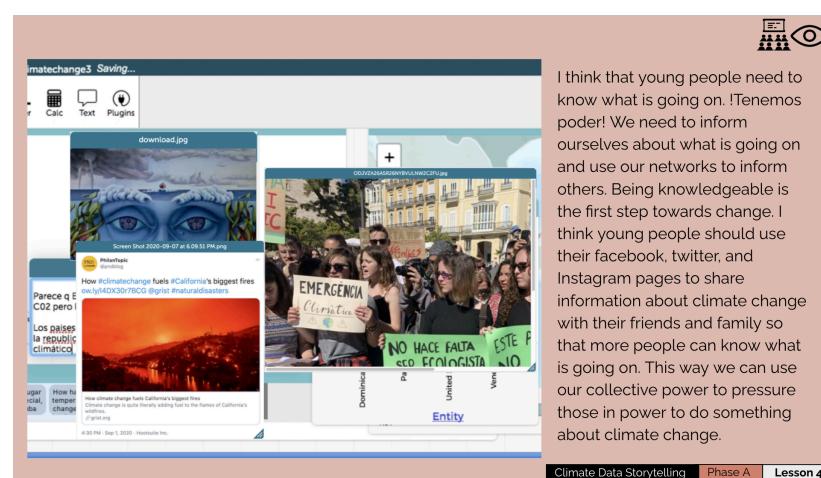
Figure 2. Slide showing Photovoice example, showing responses to 5 core questions (Photo credits: image courtesy of Voces y Manos por el Derecho a la Salud. Rabinal, Baja Verapaz).



Climate change is an issue that everyone should be aware of and care about. Climate change impacts different places in different ways. People who have the least impact to stop climate change are affected the most by the effects of climate change caused by countries that are richer and have a lot of power. Para mi, los efectos de cambio climático son los mas evidente en la fuerza y frecuencia de huracanes en el Caribe. Cuba es un lugar especial para mi y mi familia. En 2017 Huracán Irma causó mucha devastación en el país. Cuba no es un país rico como EEUU. No tiene la infraestructura para reconstruir como EEUU.



The data shows that Caribbean countries are seeing temperature anomalies that reflect the effects of climate change. Yet, these countries are not big emitters of carbon and they are poor. Bringing these things together means that these countries are least responsible for climate change but are the most impacted and the least able to do something about it. When compared to the United States, these countries are not making the problem worse. Countries like the United States need to take responsibility and fix their policies to reduce their impact on climate change.



I think that young people need to know what is going on. ¡Tenemos poder! We need to inform ourselves about what is going on and use our networks to inform others. Being knowledgeable is the first step towards change. I think young people should use their facebook, twitter, and Instagram pages to share information about climate change with their friends and family so that more people can know what is going on. This way we can use our collective power to pressure those in power to do something about climate change.

Figure 3. Teacher's example of writing a data story, shifting from initial text and photos of the Photovoice into layered data tables, data maps, scatterplots, photographs, tweets, and text documenting what is, why it is and what could be

Carbon Emissions CODAP Screenshot

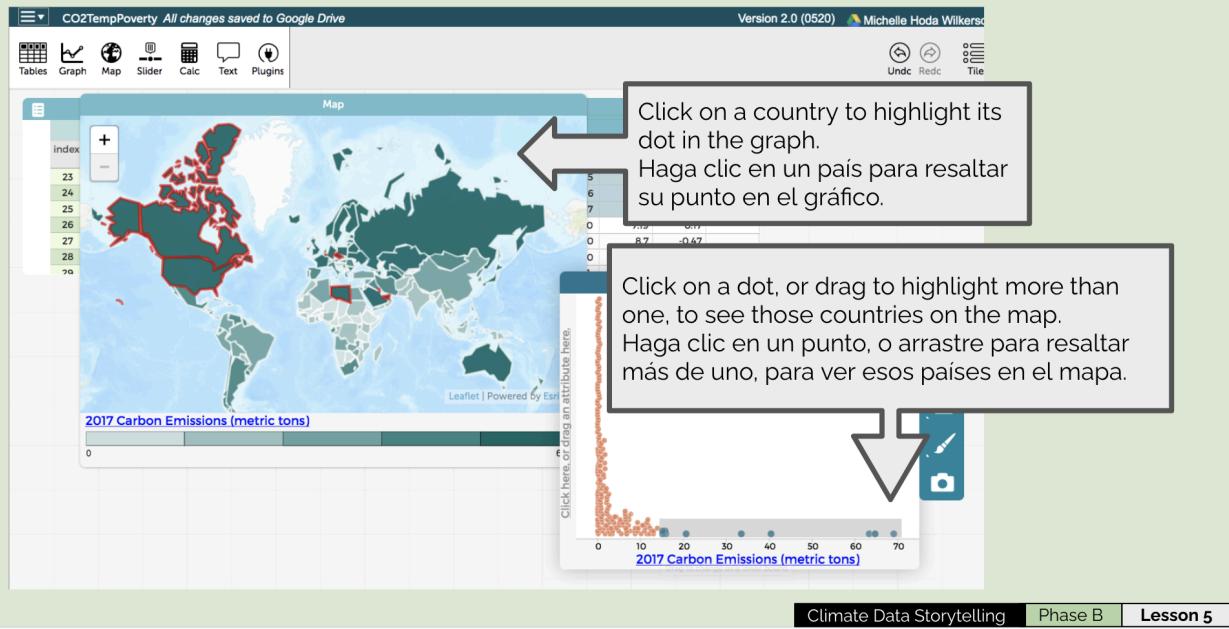


Figure 4. CODAP example demonstrating the interlinking of representations. The data points representing the highest carbon emissions are highlighted in the graph, and the corresponding countries highlight automatically in the map.

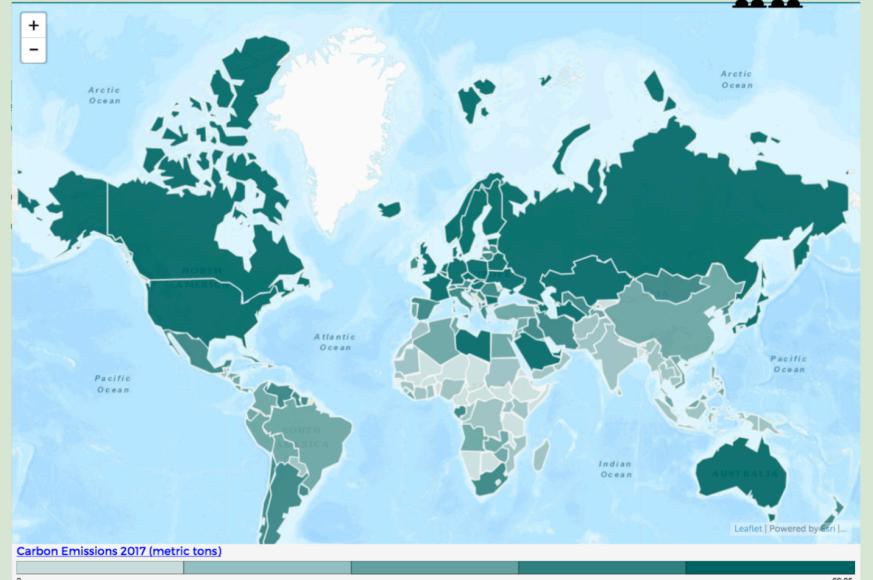
Pairs

¿Qué observas e infieres?

¿Qué sabe sobre la contribución del CO₂ al cambio climático?

What do you observe and infer?

What do you know about how CO₂ contributes to climate change ?



Climate Data Storytelling | Phase B | Lesson 5

Figure 5. This is an example of a choropleth map that student pairs analyzed. It shows CO₂ emissions in metric tons per country, with lighter coloration representing lower carbon emissions and darker coloration representing higher carbon emissions.

Tormenta de ideas / Brainstorm



Preguntas orientadoras

- ¿Cuál es el argumento que quieras hacer?
- ¿Qué evidencia necesitarás para apoyar ese argumento? ¿Cómo puedes mostrarlo?
- ¿Cómo puedes convencer a tu audiencia?
- Piense en la edad, el género, la ubicación, la educación, etc. del público. ¿Cómo su mensaje y audiencia configuran lo que pondrá en su historia de datos?
- ¿Qué idioma será más efectivo?
- ¿Cómo organizará los datos?

Guiding questions

- What is the argument you want to make?
- What evidence will you need to support that argument? How can you show it?
- How can you convince your audience?
- Think about the audience's age, gender, location, education, and so forth. How does your message and audience shape what you will put in your data story?
- What language will be most effective?
- How will you organize the data?

Climate Data Storytelling | Phase C | **Lesson 9**

Writing a narrative argument



Name:

Presentation day:

Instructions

- Each group will write a 3 paragraph narrative argument
- The narrative argument tells a message to an audience to inspire them to take action to change a problem
- You will use the data you collected in CODAP to support your argument. Each paragraph will have at least 5 sentences

Paragraph 1: Why is your story important?

Notes:

Paragraph 2: What data do you have? What does it show/explain?

Notes:

Paragraph 3: What are your suggestions for change? Why are you speaking to this particular audience? What would you like them to do?

Notes:

Climate Data Storytelling | Phase C | **Lesson 10**

Figure 6. Student Worksheet Supports: Brainstorm Prompts and Structure for Building Data Story

Rubric for the CODAP-Based Data Story

	4- Mastery of Standards	3- Proficient in Standards	2-Approaching Standards	1-Needs Significant Improvement
Data Analysis	<ul style="list-style-type: none"> *Adeptly uses and interprets all three types of data visualizations (maps, tables, and scatterplots) *Adeptly identifies patterns by making connections across at least two data variables (among carbon emissions, water, poverty, and temperature) 	<ul style="list-style-type: none"> *Accurately uses and interprets at least two types of data visualizations (maps, tables, or scatterplots) *Accurately identifies a pattern in at least one data variable (among carbon emissions, water, poverty, and temperature) 	<ul style="list-style-type: none"> *Attempts but does not appropriately use data visualizations (maps, tables, or scatterplots) *Attempts but does not accurately identify patterns in the data 	<ul style="list-style-type: none"> *Does not use data visualizations *Does not identify patterns in the data
Elements of a data story	<ul style="list-style-type: none"> *Adeptly includes text and images *Adeptly makes connections among text, images, and data patterns *Adeptly makes connections to climate change and their special place 	<ul style="list-style-type: none"> *Includes text and images *Makes connections among text, images, and data patterns *Makes connections to climate change and their special place 	<ul style="list-style-type: none"> *Does not appropriately include text or images *Does not appropriately connect text, images, and data patterns *Does not appropriately make connections to climate change and/or their special place 	<ul style="list-style-type: none"> *Does not use an image or text *Does not make connections to the data patterns *Does not make connections to climate change/ and or their special place
Evidence Based Argument	<ul style="list-style-type: none"> *Adeptly makes an argument about all three focal climate change elements: the current situation (what is); causes (why it is); and actions to support a more just future (what could be) in their argument * Adeptly uses text, images and data as evidence in the argument 	<ul style="list-style-type: none"> *Makes an argument about at least two focal climate change elements: the current situation (what is); causes (why it is); and actions to support a more just future (what could be) * Uses text, images and data as evidence in the argument 	<ul style="list-style-type: none"> *Attempts to make an argument about focal climate change elements: the current situation (what is); causes (why it is); and actions to support a more just future (what could be) * Ineffectively uses text, images and data as evidence in an argument 	<ul style="list-style-type: none"> *Does not make an argument about focal climate change elements: the current situation (what is); causes (why it is); and actions to support a more just future (what could be) *Does not attempt to use text, images or data as evidence in an argument
Audience and message	<ul style="list-style-type: none"> *Data story adeptly communicates a message about action for change *Message is adeptly tailored for a specific audience 	<ul style="list-style-type: none"> *Data story communicates a message about action for change *Message is tailored for a specific audience 	<ul style="list-style-type: none"> *Data story communicates an inappropriate or ineffective message about action for change *Message is not tailored for the audience 	<ul style="list-style-type: none"> *Data story does not include a message about action for change *Data story does not suggest a specific audience

Figure 7. Rubric for Data Stories and Final Presentations of Data Stories

Mi lugar / My Place



¿Cómo se relaciona esto con NUESTRAS vidas? How does this relate to OUR lives?

Esto se relaciona con nuestras vidas de varias maneras. Tengo muchos familiares que viven en Cuba y me preocupa que no tengan acceso garantizado a la electricidad. La electricidad no sólo es importante para tener luces, aire acondicionado e internet, sino que también es importante para cosas como la refrigeración y la cocina. Esto crea muchos otros problemas cuando no hay electricidad. También me pregunto si suficiente gente conoce las condiciones en Cuba porque no escucho a mucha gente hablar de ello.

This relates to our lives in several ways. I have a lot of family that lives in Cuba I worry about them not having guaranteed access to electricity. Not only is electricity important to have lights and air conditioning and internet, but it also is important for things like refrigeration and cooking. This creates a lot of other problems when there is no electricity. I also wonder if enough people know about the conditions in Cuba because I don't hear many people talk about it.

Figure 8. Cuba PhotoVoice Example. This is an example of a Photovoice, for the specific question “How does this relate to OUR lives?

Data Story Brainstorm Sheet

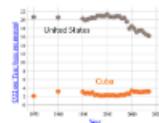
Use this to keep track of the things you learn while you explore data about your special place.



Our special places:
Cuba
Guatemala

Our message is: *Our countries do not emit a lot of CO2 but we suffer from the impacts of high CO2 emissions from other countries but are least able to deal with them.*
Our audience is: *Middle school students from our countries*

I see:



This shows:

Las emisiones de CO2 han aumentado en Cuba en los últimos 30 años. Pero en general las emisiones no son tan altas como las de Estados Unidos. CO2 emissions have gone up in Cuba over the last 30 years. But overall the emissions are not as high as the U.S.

This is important because:

Respalda nuestra afirmación de que la gente en Cuba sufre el impacto de las emisiones de CO2 aunque no sean la causa de las altas emisiones de CO2.

It supports our claim that people in Cuba suffer from the impact of CO2 emissions even though they are not the cause of high CO2 emissions

I see:



This shows:

*Both countries are getting hotter each year.
Los dos países se están calentando cada año.*

This is important because:

Even though Cuba has much less emissions, both countries are showing the effects of warming.

Aunque Cuba tiene muchas menos emisiones, ambos países están mostrando los efectos del calentamiento.

I see: (sketch image, graph, or pattern in the data)



This shows:

The emissions from each country are different and you can see on the map they are lighter colored, but all countries are bright for temperature change. The U.S. CO2 per person is over 16 but Cuba and Guatemala are lower than 4. Even though Guatemala has the lowest CO2 emissions, it does not have the lowest temperature change.

Las emisiones de cada país son diferentes y puedes ver en el mapa que son de colores más claros, pero todos los países son brillantes por el cambio de temperatura. El CO2 por persona en EE.UU. es superior a 16, pero Cuba y Guatemala son inferiores a 4. Pero todos tienen temperaturas en aumento (EE.UU. es de 1.44 grados y los demás países tienen alrededor de 1 grado). Aunque Guatemala tiene las emisiones de CO2 más bajas, no tiene el cambio de temperatura más bajo.

This is important because:

The amount of pollution affects other countries.

La cantidad de contaminación afecta a otros países.

Figure 4. Cuba Data Story Paired Comparison Activity. This worksheet is used by student pairs, as they contrast their special places (Cuba, Guatemala) and the different layers of data and data visualizations that they analyze, visualize and interpret.