

Polar-ICE Data Stories: Putting Real Data from Polar Regions into the Hands of Students

BY HOPE BIGWARFE AND STACEY SEBERT



Students discussing the Warming Arctic Data Story. Courtesy of Stacey Sebert

INTRODUCTION

The National Science Foundation funded Polar-ICE project created a series of *Data Stories* to share from the Arctic and Antarctic. In short, the *Data Stories* are easy-to-use, interactive, online stories focused on engaging students with real-world data. The emphasis is on students driving their learning through data interpretation. The activities discussed here are applicable to a variety of learning environments, opening the opportunity to engage students with real-world data and reinforce the Polar Literacy Principles (<https://polar-ice.org/polar-literacy-initiative/>).

The *Data Stories Series* were released during the 2017-18 academic year, providing a platform to make Polar Science interesting and digestible by partnering with polar researchers telling compelling stories told through narrative, interactive visualizations.

- Each month the Polar-ICE staff hosted a 60-minute webinar to launch a *Data Story* that featured a scientist whose data was highlighted. Teachers were encouraged to watch the webinar that pertained to the *Data Story* they would like to use in advance in order to gain a greater understanding of the subject matter.
- A few weeks after each webinar, the Polar-ICE staff would post an audio recording of the scientist responding to open-ended questions that were placed at the end of each *Data Story*. This content was then used by the students to work through during the activity.

The Polar-ICE *Data Stories* are flexible, data-driven activities that connect students to the researchers and stories within the data from the Polar Regions. Each *Data Story* is built around a research-based approach to helping students learn with data (Kastens, Krumhansl, and Bake 2015; Kastens and Krumhansl 2017). Each *Data Story* is a set of sequential pages through which the story builds and students are

asked to make sense of the data. To learn more about the process of developing the Data Stories, check out the Hunter-Thomson et al. article in this issue, and to explore the Data Stories visit <https://polar-ice.org/focus-areas/polar-data-stories/>. Each Data Story comes with a student worksheet that can either be completed digitally or printed out.

Of the eight Data Stories available on the website, we have used five in our classrooms to date. Here we will discuss how we integrated two of the Data Stories across our different educational settings: “As Ocean Temperatures Increase, how will Icefish do?” taught in a small, alternative education setting, and “What are the Effects of a Warming Arctic?” taught in a suburban middle school setting.

INTEGRATING POLAR DATA INTO TEACHING

How You Could Use the Data Stories in Your Classrooms

Engage: The Polar-ICE Data Stories pique student interest and get them personally involved in the lesson, tying in near real-time data collected by scientists on interesting topics that students naturally want to learn more about.

Explore: Involve your students in a topic you are already exploring. The Data Stories enable students to work with data in easy to understand models of what is happening in the Polar Regions, allowing students to forge their own conclusions on the topic.

Explain: Provide students with an opportunity to communicate what they have learned so far regarding a science topic. Data Stories ask probing questions, making students predict what they think will happen without providing them the answers to the questions. Having students discuss potential outcomes at this state is crucial to understanding what the student is thinking and where they are coming from.

Evaluate: To enable students to demonstrate their knowledge of a topic area using data and a new system, consider integrating a Data Story into your Summative Assessments at the end of the unit or school year. The Data Stories do not provide the answers for students, but instead provide the evidence needed to make conclusions and ask students to provide their reasoning so they can easily be used as an assessment instrument.

Extension Activities: Polar-ICE Data Stories allow students to use their new knowledge and continue to ask questions and explore implications in new and unfamiliar situations, meaning you can use them for a variety of extensions. Each Data Story includes links to related lessons most created

by educators attending various polar-related professional development programs including but not limited to: Polar Teachers and Researchers Exploring and Collaborating (PolarTREC: <https://www.polartrec.com/>), and Monterey Bay Aquarium Research Institute Education and Research: Testing Hypotheses (MBARI EARTH: <https://www.mbari.org/products/educational-resources/earth/>).

Why You Should Try It

Using Data Stories is a great way to bring near real-time data into the classroom. Data Stories also show the real-world connection and present the reality that there may not be a clear answer to the questions that are asked. The students were actively engaged with the material and liked working with the data. As teachers, we liked how easy it was to integrate into our classroom teaching, and how it made working with data more real for our students. Here is how we integrated two Data Stories into our classrooms.

CLASSROOM IMPLEMENTATIONS OF DATA STORIES

EXAMPLE 1 DATA STORY:

As Ocean Temperatures Increase, how will Icefish do?

This Data Story uses data collected by Dr. Kristin O’Brien on Icefish. Icefish are an Antarctic fish species with no hemoglobin in their blood. This peculiar trait is an example of a phenomenon to get students thinking about the impact that rising water temperatures may have on animals living in a polar ocean. The first few pages of the Data Story provide background information on the Icefish, hemoglobin, and the amount of dissolved oxygen in ocean water at different temperatures. The students are then prompted to choose one of the provided hypotheses to answer the focus question: “How will these fish (without hemoglobin) perform in ocean waters with warming temperatures as compared with other fish (with hemoglobin)?”. The middle pages take students not only through the data, but also through the data-collection processes to understand how the data is derived, giving them the opportunity to see how scientists are researching this question. In the final pages of the Data Story, students are presented the data that Dr. O’Brien has collected with prompting questions to help the students analyze the data on their own. This allows students to interpret the data in the graphs provided and draw a conclusion to the focus question, determining if the hypothesis they chose was supported or not based on the data provided.



Students filling out the KWL before starting the Warming Arctic Data Story. Courtesy of Stacey Sebert

This Data Story uses the Hypothesis Array approach to having students work with data (Kastens and Krumhansl 2017). The Hypothesis Array approach is useful when students may not have a strong enough knowledge base of a topic to make a detailed and informed prediction. In this approach, students are presented with multiple working hypotheses. They choose one hypothesis and investigate data related to the topic. Finally, they use the evidence they gathered from their data to support or refute their chosen hypothesis.

Topics

Ecology
Body Systems
Climate
Natural Selection

Learning Environment

Alternative Education High School Students vary in age from 14-21 years old and are at-risk of not successfully completing high school.

ALIGNMENT WITH STANDARDS

Ocean Literacy Principles

5. The ocean supports a great diversity of life and ecosystems.

Polar Literacy Principles

5. The Poles are experiencing the effects of climate change at an accelerating rate.

Next Generation Science Standards

Interdependent Relationships Among Ecosystems:

- MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
- HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Ecosystems: Interactions, Energy, and Dynamics:

- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Natural Selection and Evolution:

- MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
- HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1.) increases in the number of individuals of some species, (2.) the emergence of new species over time, and (3.) the extinction of other species.

Teaching Time

20-30 minutes (typically)

Procedure

1. Students used Chromebooks, in small groups or one-on-one setting, depending on student need, with teacher guidance.

2. Students and teacher read through the first few pages of the Data Story online, answering background questions on a [worksheet](#). While doing this, the teacher also facilitated a discussion of key components of Ecology, Human Body, and Climate as related to the Data Story, tying these back to the curriculum.
3. After the background information, students began a Claims, Evidence, Reasoning (CER) by choosing one of three possible hypotheses provided as their claim.
4. The students then worked independently, continuing through the Data Story and analyzing the graphs of data to gather evidence, with support from the teacher as needed.
5. Students drew a conclusion as to whether or not their chosen hypothesis was supported by the data from the story.
6. The teacher facilitated a discussion among students regarding which claims they chose, if their evidence supported their claim, and what next steps they would take if they were the scientist.

SUMMARY

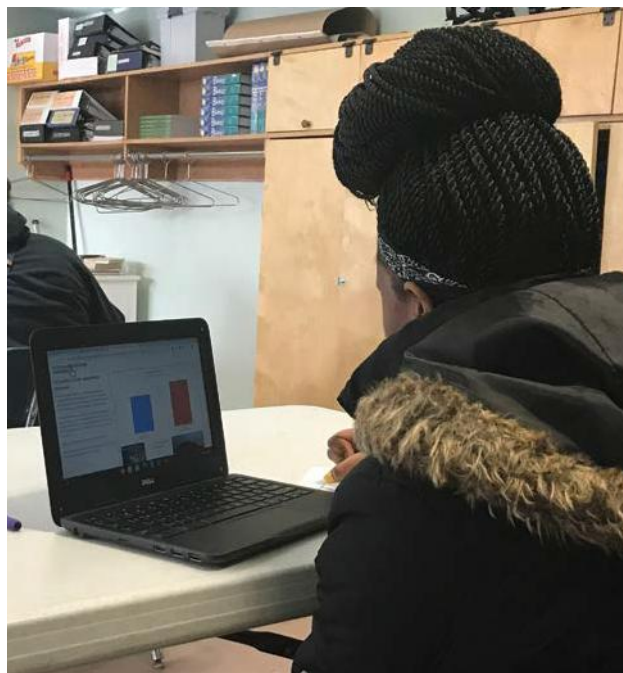
This activity was used to engage at-risk students, providing them an opportunity to explore real-world data using engaging phenomenon, while also applying concepts from multiple curriculum areas previously studied. These students work in a teacher-supported, computer-based, self-paced setting based on their individual needs and, therefore, are studying topics within the Living Environment (Biology) curriculum at different times. The students enjoyed the “weirdness” of the fish with white blood, engaged in the struggle to interpret the data, and participated in discussions extending the exploration of the different topics involved.

They struggled with not having the answer given to them at the end and having to come up with it on their own by using the data provided. They enjoyed seeing how scientists work to draw conclusions from the data. Comments made by students throughout the activity included:

This was really cool. I liked reading what a scientist really did.

This helped me learn better. I understand things more when it's all together like this.

Those fish are freaky.



High school student completing the Data Story, *As Ocean Temperatures Increase, how will Icefish do?* Courtesy of Hope Bigwarfe

Extension Activities for *As Ocean Temperatures Increase, how will Icefish do?*

- Antarctic Adaptations: <https://www.polartrec.com/resources/lesson/antarctic-adaptations>
- Frozen fish? Unique adaptations of Antarctic fish: <https://www.polartrec.com/resources/lesson/frozen-fish-unique-adaptations-of-antarctic-fish>

EXAMPLE 2 DATA STORY:

What are the Effects of a Warming Arctic?

This phenomenon-based Data Story guides students through data that Dr. Matt Druckenmiller uses for his research and asks the question: “What ecological shifts have occurred in the Arctic as air temperature has increased over time?”. The story begins by introducing the topic, giving students background knowledge on how the ocean impacts the surrounding environment. Before diving into the data, some information on what sea ice includes is given on the introductory slide. As students’ progress, they are asked to make predictions on what the data will look like before they actually see the data. Then data for air temperature and sea ice extent are provided through interactive graphs. Students are able to make observations about the square footage of sea ice discussed and data on the depth of the sea ice. There are interactive models to show the extent of sea ice melt and compare it to the size of the U.S., so students have a great

comparison as to the amount of sea ice that has melted over time in order to understand the numerical values of the data. The Data Story concludes with an open-ended question where the students are asked how melting sea ice will affect plants and animals in the Arctic.

This Data Story uses the Predict-Observe-Explain approach for students working with data (Kastens et al. 2015). The Data Stories include large data sets, so using the Predict-Observe-Explain approach will help students explore the data and better understand the natural process of collecting data. Students will Predict the outcome of the data based on certain circumstances, Observe the model within each Data Story, then finally Explain what they observed.

Topic

Polar Regions
Human Impact on the Environment
Climate Change

Learning Environment

Middle School Science

ALIGNMENT WITH STANDARDS

Ocean Literacy Principles

1. The Earth has one big ocean with many features.
3. The ocean is a major influence on weather and climate.
6. The ocean and humans are inextricably interconnected.

Polar Literacy Principles

2. Ice is the dominant feature of the Polar Regions.
5. The Poles are experiencing the effects of climate change at an accelerating rate.

Next Generation Science Standards

Ecosystems: Interactions, Energy, and Dynamics:

- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of ecosystem affect populations.

Earth and Human Activity:

- MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Teaching Time

Depending on how the activity is implemented and discussed anywhere from 20-60 minutes. (Note: This is the longest Data Story in the series, other Data Stories can take less time.)

Procedure

1. You will need computers for students to access the Data Story and/or possibly an overhead projector to project the Data Story for the entire class to work through.
2. Students complete the first two parts of a Know, Wonder, Learn (KWL) chart. What do you Know about a warming Arctic, and what do you Wonder about a warming Arctic? Then those answers are discussed as a class. Many of my students Wondered how long until all the sea ice melts and how will that impact the Earth. The worksheet can be found [here](#).
3. Students then went to the Data Story Introduction, answering questions and making predictions along the way. My students each had their own laptop, but were partnered with a neighbor to discuss as they worked through the activity. You can hold class discussions at certain points of the Data Story, have students Turn and Talk to a partner, or simply have the students work alone on the Data Story—it's really up to how you want to implement the activity and how much time you want to spend on it. Students can go at their own pace with the Data Story.
4. As students are working through the Data Story, they can fill out a CER (Claims, Evidence, Reasoning) for "Why the Arctic is warming," writing a claim then giving evidence through the data, and then a reason based on scientific principles that defend the claim and evidence. Many of my students Claim was "If the Arctic is getting warmer because of global warming then animals will have to adapt to the new environment because that's what they have to do if they want to live." Their Evidence statement was "The temperature and ice extent are increasing then decreasing because of the seasons, but the general trend is the air temperature is increasing and ice coverage is decreasing."
5. The conclusion of the Data Story is open ended. Students are asked, "What does this all mean for plants, animals, sea ice?" Students then went back to the KWL chart and answered the question, "What did you Learn about the warming Arctic?" One student responded, "I learned that more than just the water level is affected by

the warming Arctic and that animals, temperature, and plants are affected by global warming. I hope we find a way to protect the animals because they are in a lot of danger with their habitat melting away. This activity was pretty cool.”

SUMMARY

There is a sort of frustration from students at times since this activity isn't cut and dry where they read the material and find the answer, (i.e. copying and pasting the answer in the space provided). Students need to think about the cause and effect because the answer isn't right there in front of them. Many of the students overcame their frustration by talking with other students about the activity and coming to a common cause. A few of them wanted confirmation about what they were thinking caused the sea ice to melt by discussing their thoughts with me. Despite this frustration, many students reflected at the end with sentiments like “I liked this activity because we could go at our own pace and it made us think in different ways to find the answer.” This left many students wanting to learn more about the warming Arctic!

Extension Activities for *What are the Effects of a Warming Arctic?*

- Have an Eye in the Sky: <https://www.mbari.org/earth-2017-day-5/>
- What's the Bigger Picture?: <https://www.mbari.org/what-is-the-bigger-picture/>
- Melting Glaciers: <http://coseenow.net/antarctica/Activity%201%20Melting%20Glaciers.pdf>
- Amazing Albedo: <https://www.climate.gov/teaching/resources/amazing-albedo>
- Land Ice, Sea Ice and Sea Level Rise: <https://www.polartrec.com/resources/lesson/land-ice-sea-ice-and-sea-level-rise>

ADDITIONAL RESOURCES

- www.climate.gov
- www.coseenow.net
- www.mbari.org
- www.meetthegreens.org
- www.polar-ice.org
- www.polartrec.com
- <https://lab-aids.com/sites/default/files/2017-03/science-teacher-Krumhansl-articles.pdf>
- <https://files.eric.ed.gov/fulltext/EJ1161354.pdf>

REFERENCES

Additional articles, and references and abstracts for all contributions are available on Polar-ICE (https://polar-ice.org/nmea_current/) and NMEA (<https://www.marine-ed.org/s/Polar-Ice-Resources-Current.pdf>) sites.

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STACEY SEBERT has been teaching middle school science for over 17 years at South Colonie. She is a part of the New York State Master Teacher Program, is recognized as a leader of Women in STEM, has won several awards including the 2019 STANYS Excellence in Teaching Award, a teacher fellowship with Ecology Project International, and is a Maitland Simmons Scholar. Stacey has attended several EARTH workshops, developing some of the extension lessons offered above.