

Bring on the Polar Data: Two Approaches to Connect Students with Polar Data through the Polar-ICE Project

BY KRISTIN HUNTER-THOMSON

INTRODUCTION

Through the Polar Interdisciplinary Coordinated Education, or Polar-ICE Project, we explored different ways to connect teachers and students in elementary through high school to the Polar Regions. Getting all of our students to the Poles is impossible, and getting teachers to the Poles can be expensive and challenging. Fortunately, the number of instruments deployed in the Polar Regions that are collecting data and uploading it to the internet is increasing every year. Polar-ICE used these real-world data and storytelling techniques to connect new audiences to the Polar Regions.

There are numerous, teacher-vetted, high-quality lesson plans out there around key polar topics, for example, see [PolarTrec](#). Many of them in fact include data and/or information about the scientists who are conducting research in the Polar Regions. However, we identified two approaches to complement existing educational resource options. First, we wanted to put a face behind the data and create small, flexible interactive fish data experiences for students to encourage their curiosity about the Poles while practicing different data skills. Second, we wanted to support students while working with the numerous streams of online polar data to answer

their own questions and make sense of the data. We provide explanations for these two approaches below, including a description of our process for development and implementation, and a discussion of our lessons learned. Our hope in sharing these projects is that others can build and modify these resources to connect teachers and students with any science through data.

POLAR-ICE DATA STORIES: QUICK DATA INTERACTIONS THROUGH STORIES

Through the Polar-ICE Data Stories project we were interested in developing flexible, data-driven activities that connected students to the researchers and stories within the data from the Polar Regions. Our goals for these resources were to:

- expand the use of authentic polar data in teaching;
- make polar data accessible and digestible to non-science experts; and
- identify compelling research stories that can be told using narrative visualization approaches.

We also wanted to explore building these resources in a different way than a typical lesson plan. For example, could we develop the data component, make it interactive and engaging, and connect with the scientist in a way that teachers could integrate it into lessons they were already doing? We were trying to build a resource in which the students actively took part in making sense of the data and where the data was presented in a storyline, rather than a start-to-finish data-based investigation.

We first explored existing materials that combine data and digital storytelling—from educational uses to journalism—to get a sense of what existed, and how people were approaching the design and delivery of these resources. Based on this assessment, we narrowed our focus to include the following design choices, described below and an example in Figure 1:

- *Data Story Format*: We set up the pages of the Data Story sequentially so that the learner would progress through

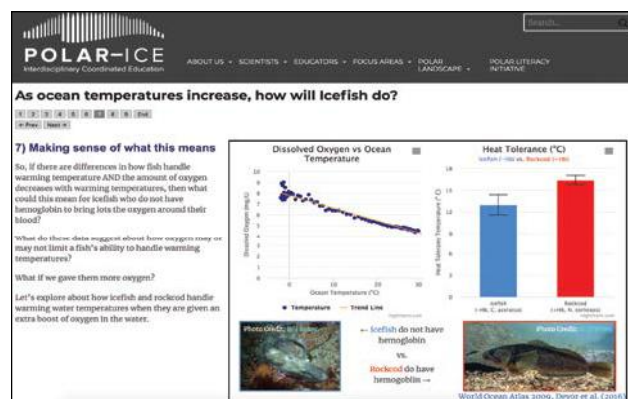


FIGURE 1. Example of step/page 7 for “As ocean temperatures increase, how will Icefish do?” data story to demonstrate design choices of these resources.

the data in a story form, while learning about the context of the research.

- *Layout and Navigation:* We chose to make the data the focal point of the page: The left one-third of the page would be text, while the right two-thirds of the page would be data. This orientation of the page would ensure that the emphasis is on students looking at and making sense of the data, rather than just reading the words to answer the activity questions. We provide text and pop up links to give learners the background information to make sense of the data and answer the question(s), but do not teach all aspects of the study system, phenomenon, etc. We chose to not provide data interpretation or analysis anywhere in the text that would directly answer the driving question for the students.
- *Levels of Data Interactivity:* The presentation of the data would include some animation so that the data components were not completely static on the page. However, the data were not completely a fully open-interactive, which provided some guidance to the learner. Instead, we focus on providing some scaffold for the user of how to interact with the data.
- *Context for Data Use:* The activity would be grounded in a driving question around a phenomenon. This could support learners in connecting the science practice of data analysis with a conceptual topic tied to the Next Generation Science Standards and other relevant state science standards.

Design Team Approach

As we were developing our design criteria and pedagogical approach, we also assembled our design team for the activities. The team included a scientist (whose work we highlighted and who contributed the data for the story), a data visualization programmer to create the resource as an online experience, a project manager, and an education developer to design the storyline tied to educational standards and current pedagogy.

We developed a prototype Data Story (*What drives patterns in ocean change?* with Dr. Josh Kohut) and piloted it with educators and scientists. We received positive feedback about the structure of the activity. However, we were concerned that it would be difficult for teachers to find the resource online unless we connected each story to a larger collection of resources. Additionally, we wanted to provide support to educators on and suggestions for how to use and integrate a Data Story into their teaching. Therefore, we decided to build the resources out as a monthly series.

The process in developing the seven additional Data Stories that were part of the Data Stories Series included the following steps. First, we identified and contacted via email potential scientists involved in a wide variety of research in the Polar Regions. If interested, we arranged for an initial phone call to discuss the project, their research, and potential story ideas and approaches. I used this for these phone calls to help identify the data available, the novel and exciting aspects of the scientists research, and the ideal takeaway messages for the Data Story. With that information and additional papers or data files provided by the scientist, I would develop an initial storyboard for the activity using this template to design the layout and identify the student learning objective.

The scientist and I would review the draft storyboard in a second phone call. At this meeting, we would discuss if the draft concept worked and then move forward, if it did. If there were issues with the draft concept, we would talk through how to revise and reorganize the story to support users for getting the takeaway message desired by the scientist. Once the storyboard concept and organization were agreed upon, we would finalize the specific data to use and how to visualize those data. At this point, the storyboard and data files would be sent to the data visualization programmer to build an initial online prototype. The scientist and I would review the prototype and share requested edits and adjustments. Once the prototype was agreed upon, we would launch the activity live a few days before the monthly webinar to enable participants to review the Data Story in advance.

Developing an Implementation Strategy

Based on our goals for the project, feedback on the pilot Data Story resource, peer-reviewed literature, and the goals of Polar-ICE, we decided to scale up the design process. Our design decisions included:

- We developed the Data Stories as a series shared during the 2017-18 academic year with a new Data Story launched once a month during an evening one-hour webinar. This created an event to signal to the community that a new resource was available to use.
- We invited the collaborating scientist to participate in the webinar to provide a broader context on their research and answer questions from the teachers. This enabled us to build in supports and valuable background information for the teachers. In addition, we published the recording of each webinar on the webpage so that those unable to attend could watch it and/or it would be available for teachers to re-watch if needed.

- We created a landing page for the full series of Data Stories. Each story has lesson plans, datasets, and other resources related to the topic(s).
- Collaborating scientists provided a short recording of their interpretation of the data. We released the audio recording on the webpage a week after the story launched. This provided the teachers with the “answer” to the Data Story from the point of view of the scientist. We envisioned that this would help the learners connect to the scientist, the data, and the research question.

Another key aspect of our redesign was that we grounded all of the Data Stories in a specific, research-based approach to developing data interactions via Design Patterns (Kastens, Krumhansl, and Bake 2015; Kastens and Krumhansl 2017). The Design Patterns that we used included (with Data Story highlighted and linked):

- Data Puzzle:
 - > What kinds of sea ice are changing?
 - > Where are those microplastics coming from and going?
- Hypothesis Array:
 - > As ocean temperatures increase, how will Icefish do?
- Make a Decision or a Recommendation:
 - > What should we do about the trees?
- Predict-Observe-Explain:
 - > What are those whales doing?
 - > What drives patterns in ocean change?
- Pooling Data:
 - > How and why are glaciers changing over time?
 - > What are the effects of a warming Arctic?

We selected an approach that aligned well with the science the scientist was involved with, and what story they wanted to tell through the activity. This helped us ground the design of the Data Stories in current research of how people learn from data; thus, greatly reducing the development time of each resource.

Results of the Data Story Implementation

We had elementary through college level teachers participate in the monthly webinar series from over twenty states and three different countries. The number of participants grew with each subsequent webinar. We also received feedback from a wide range of teachers about how they were integrating the Data Stories into their classrooms. Some used it as a “Do Now” activity; others used it as an initial “Engage” activity for a unit, or as an activity to do once students had completed a test or assignment or during extra time in class; while others embedded it into their final exam for the semester. Regardless of the way teachers implemented

the resources, we heard repeatedly that teachers enjoyed the pre-prepared data for use in an educational setting, data were related to real-world phenomenon, and students enjoyed working with the data. We are currently pursuing funding to develop more Data Stories and to translate them into Spanish and other languages.

SCI-I (SCIENCE INVESTIGATIONS) PROJECT: YEAR-LONG DATA IMMERSION

The Polar-ICE team was also interested in developing a way for teachers to meaningfully integrate real-world data, the process of science, and data skills in more depth into their curriculum and; thus, developed the year-long, data-focused immersion Sci-I Project. Our goals for this year-long data immersion experience were to increase teachers’ and students’:

- understanding of the process of science;
- confidence in designing, conducting, and presenting science investigations,
- identity as a scientist; and
- awareness of what it means to be a scientist.

We developed the program to accomplish these goals by helping students learn how to a.) write a testable question (and hypothesis) that are grounded in data; b.) respond to a scientific Request for Proposals (RFP); c.) accept critical review and modify/iterate their question and/or investigation design; d.) conduct a scientific analysis of their data; e.) develop figures to best represent their data; f.) develop a scientific poster; and g.) present their work at a Student Research Symposium. We designed the project to be collaborative between university scientists and K-12 schools as well as to represent the realistic and sometimes nonlinear practices of authentic research.

Over the 2016-17 and 2017-18 academic years, we worked with 6-9th grade teachers and students from California, Colorado, Missouri, New Jersey, and Utah. A full write up of how we developed, implemented, and evaluated the Sci-I Project is available in our Polar-ICE Sci-I Project Development & Implementation Guide.

How Sci-I Works

Each year we kicked off the program with a week-long summer institute for the teachers to experience the process of working with data, and explore how to bring these processes into their classrooms. During the workshops, we utilized the Palmer Long Term Ecological Research (LTER) data as our model data source for the teachers to collectively use.



FIGURE 2. Students presenting at the Sci-I Project Student Research Symposium to peers and scientists on June 8, 2017 in New Brunswick, NJ.

Implementation of the project into the classroom varied among the participating teachers. Some teachers had their students work on it every Friday throughout a semester, others took a week out of their curriculum to intensely focus on it, and others used one block period in their rotating schedule each week for this project-based learning. Regardless of how the teachers implemented the project, every student had to design their own question from data, submit a research proposal, and download, process, interpret and present their data and findings in a scientific poster. The other requirement was that the data the students used had to be collected from the Polar Regions by a scientist. Most students presented their work to classmates, schoolmates, and teachers within their schools. Each school was able to select some students to attend the Student Research Symposium, a non-competitive university sponsored event for the teachers and students. A select number of students were chosen to attend the event to present their work to university and industry scientists for feedback (Figure 2).

Based on teacher and student surveys as well as follow-up interviews with teachers, our evaluation results indicate that this project successfully accomplished its goals. Teachers and students found the project to be rewarding and illuminating. While it took time to allow students to explore the data and their interpretations of the data, both the teachers and students reported that the time was worthwhile. The teachers saw a large growth in students' ability to and confidence in working with and making sense of data through the project. Additionally, students were empowered and excited to share their results as scientists and as the leading experts on their data. The Polar-ICE team learned about the different ways teachers and students were (and continue to be) integrating the Sci-I Project processes of working with data into other aspects of their education. We are

currently writing up a full analysis of the evaluation data to be published in the coming year.

LESSONS LEARNED

There is a great need for educational resources that support teachers to integrate more real-world data into their classrooms, beyond just the traditional lesson plans currently available.

These programs represent two extremes in terms of classroom time commitment, scope of work, and ways of teaching and learning with data. However, both initiatives had some common design components that resonated with the teachers—and we believe were aspects of their success. For example, both programs were specifically designed to promote students' own critical thinking when using data. The students had to find their answer and support it with evidence in the data. Additionally, we developed both projects to be flexible enough that teachers could integrate them into what they were already teaching in their curriculum, rather than adding another aspect on top of their curriculum. Both of these projects were centered on using the data to explore and learn the concept. Going forward, we need to continue to provide a wide variety of ways for teachers and students to integrate data into their science content teaching and learning.

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.

ACKNOWLEDGEMENTS

I would like to sincerely thank Sage Lichtenwalner, Janice McDonnell, Lucas Marxen, Dan Farnsworth, Bridget Clarkston, Kristen Hart, and Jacoby Baker for all of their hard work on making these projects a reality. Additionally, thank you to all of the scientists for working with us on building these programs: Ari Friedlander, Ellyn Enderlin, Josh Kohut, Matt Druckenmiller, Joseph Owen Sexton, Kristin O'Brien, Alice Bradley, Alexis Janosik, Schuyler Nardelli, Hugh Ducklow, Logan Pallin, and Filipa Carvalho. Also, I want to express a deep gratitude to all of the teachers, students, and scientists who have partnered with us over the years—it has been a great pleasure getting to know and work with all of you.

KRISTIN HUNTER-THOMSON draws from her experience teaching in formal and informal education settings to develop cutting-edge science and data literacy focused content and experiences. Kristin has a master's in Marine Science from Moss Landing Marine Laboratories/San Jose State University and a master's in Earth & Life Science (middle & high School) from Lewis & Clark College.