DATA JAMS

Promoting data literacy and science engagement while encouraging creativity

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Thousands of students around the country have participated in activities using the Data Jam model, creating poetry, songs, videos, or sculpture to improve their data literacy, gain knowledge of local science research, and creatively express their findings. This article introduces the Data Jam model and how teachers can use it in classroom or after-school settings, supported by vignettes of student projects and feedback from teachers and students.

Data is the lens through which we increasingly view our world, and scientific data literacy skills are a key component of the *Next Generation Science Standards*' (*NGSS*) science and engineering practices (Berkowitz, Ford, and Brewer 2005). Understanding how to engage with data, however, can be challenging for students. Most have limited experience with authentic scientific data sets, and find them complex and intimidating (Ben-Zvi and Garfield, 2004).

Clear, creative communication is crucial to helping students (and the general public) understand data and scientific findings. Interest in creative and artistic science communication tools has increased, as evidenced by the proliferation of projects such as the SciShow YouTube video series and the Dance Your Ph.D. contest from the American Association for the Advancement of Science (see "On the web.") Inspired by this movement, four science education organizations have developed the Data Jam model to engage high school students in learning about ecological research while igniting their creativity. Students analyze and interpret environmental data sets, then communicate their findings through a creative medium. This approach also supports the STEM to STEAM (science, technology, engineering, art, and math) movement, which was initially championed by the Rhode Island School of Design as a way to capitalize on the creative synergy between art and scientific disciplines (e.g., LaMore et al. 2013).

The origin of the Data Jam model

The Asombro Institute for Science Education, which coordinates K–12 education programs for the Jornada Basin Long-Term Ecological Research site in New Mexico, organized the first Desert Data Jam in 2012. Inspired by *Flip Flop Fly Ball: An Infographic Baseball Adventure* (Robinson 2011), Asombro staff wondered if students could use ecological and sociological data to develop creative projects such as the infographics found in the book.

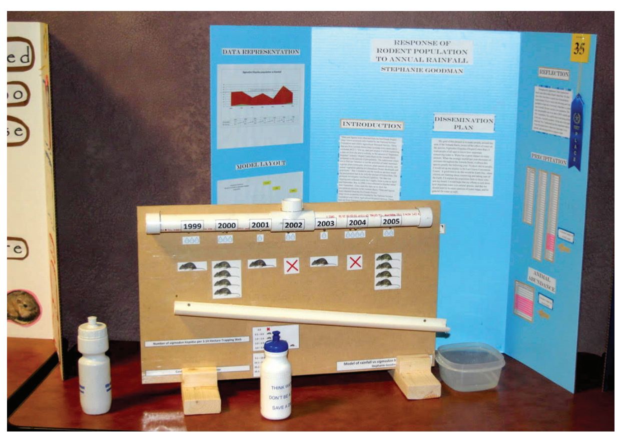
The Data Jam model has since spread across the country, reaching thousands of students. Most Data Jams have been sponsored by long-term ecological research (LTER) sites such as the Baltimore Ecosystem Study, Jornada Basin, and Luquillo (Puerto Rico). These sites belong to a network funded by the National Science Foundation to study long-term and large-scale ecological phenomena. In New York, the Hudson Data Jam is sponsored by the nonprofit Cary Institute of Ecosystem Studies. While Data Jams can strengthen connections between science institutions and schools, we believe the Data Jam model has the flexibility to be adapted to any classroom, including those who want to try Data Jam independently.

Each site in our network has implemented the Data Jam model differently based on the needs of local teachers and school districts. However, all Data Jams share six features:

- *Authentic, local data sets are provided to students.* Data can be chosen to align with important topics in the curriculum. Students may be given spreadsheets of data or pointed to data portals such as EcoTrends (see "On the web.")
- *Students engage in scaffolded and supported data exploration.* Students ask and explore answerable questions about their data. Typically, this involves looking at a trend over time or comparing variables. Students create graphs by hand or using graphing software.
- *Students create a scientific product that includes claim-evidence-reasoning.* This can take the form of a written report, poster, or presentation board. Students describe the science that produced the data, show their graph, and make a conclusion presented as a claim supported by evidence and reasoning. This helps students organize their thoughts before distilling the story for the creative component.
- *Major findings from the data exploration are communicated through a creative medium of students' choice.* We encourage students to apply their interests and hobbies to this component (e.g., dance, painting, game design, skit-writing, making three-dimensional models). We remind students to tell the story of the data, and to minimize speculation that cannot be supported by the data.

FIGURE 1

Interactive project from the Desert Data Jam showing the one-year lag time between precipitation spikes and increased rodent populations.



- *Students share their Data Jam project*. This is where students explain the story of the science to others. Sharing projects may be as simple as a gallery walk in the classroom, or as elaborate as a schoolwide, citywide, or regional exhibition.
- *Projects are assessed.* Projects can be scored by a variety of experts, from a single classroom teacher to panels of scientists and artists.

The Data Jam approach bridges STEAM and *NGSS* goals by encouraging collaboration, supporting interdisciplinary thinking, enhancing data analysis and communication skills, strengthening connections to the local environment, and fostering a deeper understanding of core scientific concepts. Students in the Cary Institute Data Jam ranked teamwork as the top skill they gained from the process. Most classes try Data Jam in small teams of approximately three students, although some students participate individually or with an entire class. The interdisciplinary research and interpretation skills used in Data Jam are important for career readiness, and the immersion in local scientific research contributes to career awareness (Bestelmeyer et al. 2015).

FIGURE 2

People's Choice Award at the Baltimore Data Jam Project Expo: Model row house representing the number of vacant buildings in Baltimore City.

While there are similarities between the Data Jam model and science fairs, there are also some key differences. In a Data Jam, students do not conduct their own scientific experiment; rather, they focus on the interpretation and communication of existing data. A second key difference between Data Jams and traditional science fairs is that the Data Jam model focuses on students creatively communicating their results through a medium of students' choice. Working with secondhand data allows students to make important and interesting discoveries that can be difficult to do using the small data sets collected in short, resource-limited lab periods. Although students do not engage in study design and execution through the Data Jam model, they access high-quality, reliably collected data sets, which allow students to engage in many inquiry-related science practices. The ability to critique and analyze data is becoming an increasingly important career-readiness skill as 21st century science embraces Big Data collected and shared by groups of researchers.

Our experience with the Data Jam Model

Since 2012, our science education organizations have created dozens of programs that use the Data Jam approach. These have evolved into different formats to meet local needs. For instance, the Asombro Institute has created programs that can be completed within a few class periods, incorporated into nontraditional classroom settings such as summer camps, or developed into regional competitions. Teachers have successfully implemented the Data Jam model on gradewide and classwide levels and as after-school enrichment projects. Some Data Jam sites provide a single data set for classes to use, while others provide dozens of data sets. The Data Jam has helped the Luquillo LTER in Puerto Rico prepare teachers and students to collect their own long-term data sets.

Feedback on Data Jams has been positive, and many teachers have participated for multiple years. In surveys from the Cary Institute, both teachers and students reported that students gained content knowledge, showed increased ability to discuss their topic, improved their data analysis skills, and increased their confidence with analyzing data. Students enjoy the creative component the most, and one student wrote, "I think that it is cool that we are making a creative piece about data that is supposed to be serious."

How can a classroom teacher implement the Data Jam model?

While we recommend joining an existing Data Jam (see "On the web"), there are many other ways that classroom teachers can implement the Data Jam approach using data local to their region. One option is to try shorter-duration Data Jam activities. For example, the Asombro Institute created the Climate Data Jam (see "On the web") as part of a curriculum unit for the U.S. Department of Agriculture's (USDA) Southwest Climate Hub. This free resource uses data on historic and predicted future temperature and precipitation in every county in the continental United States.

Based on our experience, we offer the following practical tips for implementing the Data Jam model in your classroom.

Data sets

The original Data Jams have focused on local, environmental science data sets. However, there is no limit to the types of data sets that can be used, allowing teachers the ability to implement the Data Jam model with any content area in the curriculum. Many data sets are online and easily accessible (see "On the web.") Practice finding and interpreting data sets on your own before directing your students to do so. Alternatively, just provide one or two data sets for your class.

Data exploration

Your role is to mentor students in this part of the process. Remember to let your students explore the data on their own. You can then scaffold activities in areas your students find challenging, such as graphing, data interpretation, or differentiating causation from correlation.

Scientific product

Give yourself and your students enough time to summarize their data analysis and complete the projects. Start early, and offer after-school time for students to work on their reports or poster boards. Students need a firm understanding of the content to interpret the data and then creatively communicate trends from a large data set. They build this knowledge through background research and critical thinking about the concepts that support their data analysis. The process of creating the final product helps students crystallize their understanding of disciplinary core ideas.

FIGURE 3

Wood blocks of Hudson River fish, used to represent the diversity of fish in various sites along the river.

Creative communication

Students enjoy the creative aspects of Data Jam, which motivates them through the challenges of data analyses. One 2017 New York Data Jam teacher wrote, "Students who didn't previously like science really enjoyed working on the creative project ... it provided a window into understanding the science." While students should have freedom to express their findings using any format they choose, it is important to emphasize that the creative project should accurately represent the data in an appealing way.

The creative component also allows students to make personal connections to local data through their art medium of choice. For example, the Luquillo Data Jam experience in Puerto Rico gives students a means to explore environmental disturbances such as droughts and hurricanes that they have experienced firsthand, and provides an outlet for them to express their feelings about the experience (McGee and Rodriguez 2017).

Sharing

This is an opportunity for students to build communication skills. This can take many forms, from a classroom gallery walk to a public exhibition or presentation to the scientists who collected the data.

Assessment

A sample rubric for the presentation board format is included as an online supplement; the rubric for a written report format follows a similar structure, and an example is available on the Cary Institute Data Jam web page (see "On the web.") Our organizations incentivize Data Jam competitions with monetary

FIGURE 4

A student from Rio Grande, Puerto Rico used a Chinese drawing technique to represent the 2015 drought in the Loíza Reservoir.

prizes, certificates, medals, movie passes, and/or schoolwide recognition. However, the Data Jam model is not contingent on the competitive aspect; it can be applied within a classroom for a grade or extra credit.

Putting it all together

The following vignettes illustrate how students successfully and creatively interpreted their data.

In 2013, a student from Mayfield High School (New Mexico) won first place in the Desert Data Jam (Figure 1, p. 49). She built an interactive physical model that represented annual precipitation and the population size of a common desert rodent over several years. Holes in a PVC pipe represented the amount of precipitation each year; for wetter years, more water flowed through the holes. Water flowed in front of a laminated board with pictures of the rodent scaled to show the population size. The model clearly illustrated a one-year lag between high-precipitation years and rodent population increases.

Inspired by a 2016 study examining Baltimore's shrinking population, a team of students from Western School of Technology and Environmental Science selected a data set about vacant buildings (Figure 2, p. 50). Students constructed a large row house out of cardboard and attached 17,000 Cheerios, which was the approximate number of vacant buildings in Baltimore in 2014. Their project helped the audience understand the magnitude of 17,000 vacant buildings. This team successfully communicated their data set while engaging their audience's emotions, which earned them the People's Choice Award for the 2016 Baltimore Data Jam.

Additional examples from New York (Figure 3, p. 51) and Puerto Rico (Figure 4, p. 51) show the significant variety of data sets and creative ideas that make Data Jam so exciting.

FIGURE 5

Major challenges and tips for a successful Data Jam.

Challenge	Advice From Teachers
Making sense of large datasets	"Do some instructional lessons on how to analyze data and interpret data. Students need to learn about different types of graphs."
	"Model beforehand with easier and more familiar data sets."
	"Don't make snap judgments about the data sets, look at the data several times and write a new question each time. Then start thinking about your project, but keep looking at the data and asking questions."
	"Practice finding and interpreting data sets."
Time management	"Keep to the deadlines, even submit work early. Learn how to prioritize your time."
	"Create a time schedule for getting specific aspects done."
	"Start early by identifying data sets in the fall."
Working in a team	"Help your students through each step one at a time as a group, allowing them to help and critique each other."
	"Make sure each team includes a student that is very creative."
Maintaining motivation during a challenging long-term project	"Enjoy the process and know at the end you completed a long-term project; even if you don't win a prize these skills are necessary for you in the future and make you feel good about your ability to accomplish something that not every kid your age can do. Don't be afraid to give or take advice and encouragement from other teams. Celebrate everybody's success at the end of the process."
	"Keep encouraging the kids to have fun with the projects and research."
Developing a creative project	"Giving students the choice to work on what they want is important."
	Note: This is where students can really show their individual talents and interests. For instance, we've had students tell the story of deer population changes by doing wheelies on dirt bikes and we've seen great data stories emerge through spoofs on their favorite pop shows. We love seeing what students come up with!

Planning and producing the creative component of the Data Jam is motivating but also challenging. Students get excited about this part of the project, but can stray from the content of the data. For instance, in 2014, a team of Baltimore students chose a data set on local stream chloride concentrations. Their data analysis was excellent, but their creative project championed trash prevention in Baltimore Harbor. Providing students with some simple tips and reminders can help them avoid creating projects that are disconnected from their data set. For example:

1. Provide students with the judging rubric. As they complete portions of their projects, they can check off each line in the rubric. This will help students stay on task.
2. Show students examples of creative projects that score well and those that don't. Exemplar projects such as those found on the Data Jam websites (see "On the web") should include those that successfully integrate data.
3. Work with an art teacher or local artist. Data Jam is an interdisciplinary project. Ensure your students have access to experts in science, math, and art (and perhaps even writing!).
4. Reach out for support from organizations with experience implementing the Data Jam approach.
5. Adjust Data Jam to meet your students' needs.

Teachers report that the Data Jam can be very challenging, albeit worthwhile, for their students. One Baltimore teacher exclaimed that the most important thing she got from the Data Jam was "seeing the students take pride in something they worked hard on," while another was thrilled to watch "some hidden creativity emerge" in her students. Tips for addressing the major challenges of Data Jam are summarized in Figure 5.

And finally, as one 2015 Data Jam teacher advised, "have fun with it!"

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ON THE WEB

Asombro Institute for Science Education (New Mexico): *www.asombro.org/desertdatajam*

Baltimore Ecosystem Study (Maryland): *http://beslter.org/frame5-stuff.html*

Cary Institute of Ecosystem Studies (New York): *www.caryinstitute.org/students/hudson-data-jam-competition*

Climate Data Jam (developed by Asombro Institute for USDA Southwest Climate Hub): *https://swclimatehub.info/education/climate-change-and-water-cycle*

EcoTrends Database: https://ecotrends.info

Luquillo LTER/CZO (Puerto Rico): *http://criticalzone.org/luquillo/education-outreach/k-12-education-luquillo*

SciShow: *www.youtube.com/user/scishow*

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