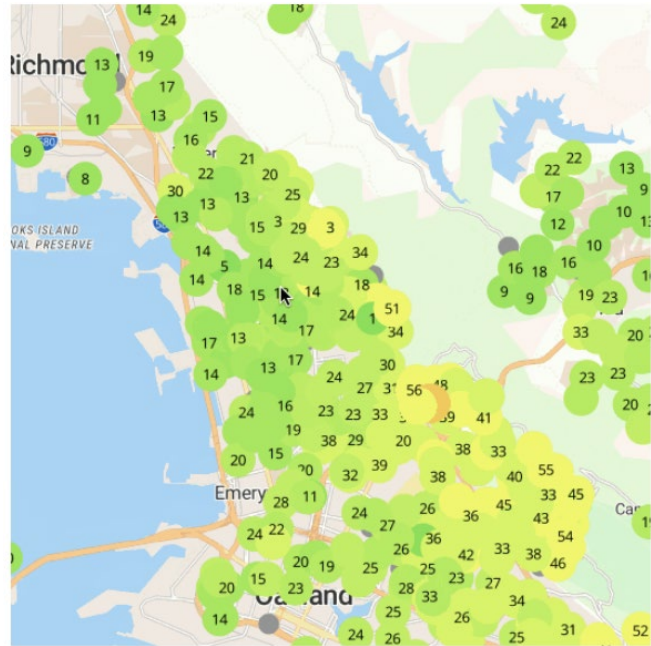


EXPLORING AIR QUALITY MODULE FACILITATION GUIDE

About this module

In this module, students will use PurpleAir and its related data to explore similarities, differences, and patterns in air quality—locally, regionally, and across the nation. Through scaffolded learning experiences and with interactive visualizations of air quality, students will collaborate with peers to investigate questions, develop conjectures, and defend conclusions related to the data. Teachers will be supported with comprehensive guidance and tools to effectively engage students in understanding fundamental data science concepts, organize student teams for project-based explorations, and guide students in developing presentations of their investigations.



Goals and objectives

In this module, students will:

- Understand the role of data in the real world.
- Ask data-based questions.
- Collect and manage data.
- Explore data to make sense of and represent the story that the data are telling.
- Use data to inform decision making.

Prerequisite skills

- Understanding of measures of center
- Understanding of graphical visualizations of data (histogram, box plot, scatter plot)
- Use of spreadsheets for data analysis

Module materials

- [Exploring air quality module](#)
- [PurpleAir](#)
- Student Activity Sheet 1: [Warming Up with the Data](#)
- Student Activity Sheet 2: [Presentation Development Tool](#)
- Student Activity Sheet 3: [Team Presentations Reflection Tool](#)
- Student Activity Sheet 4: [Presentation Rubric](#)



Opening and framing questions

In this module, you will be looking at Air Quality Index (AQI) scores around the world and locally. For many people, the quality of the air in their communities affects their daily activities. We hear about air quality on the news and through social media. Ask:

- *Do you ever hear about issues with air quality in your community?*
- *How do you think air quality affects people's daily activities?*

Facilitator notes

Overview

- Use the opening and framing questions to engage students in thinking about the value of studying air quality. Ask students to share their own experiences with air quality. Depending on the region you live in, students may already be very familiar with air quality monitoring sites, like Purple Air, while other students may have never thought about air quality.
- Use the content on the Exploring air quality module *Overview* page to give some general information about the connection between air quality and health. Ask:
 - *What do you think impacts the quality of the air we breathe?* [Wildfires, industry or car emissions, chemical factories, etc.]
- Give students time to explore the impacts and factors that affect air quality with some web searches. Here are a few sources you can share if students are struggling to find concise information.
 - [National Weather Service](#)
 - [US Air Quality Index](#)
 - [Air Now](#)
- Show the [Purple Air website](#) and give some background information on Purple Air. There are many websites that give information about air quality, but Purple Air is an example of a site that collects data from citizen scientists around the world and presents real-time and historical data on air quality.
- Ask students to go to the Purple Air website and click on **View the Map**. The map will use their location to show the sensors in their local area. Students can zoom in and out and move around the map.
- Give students time to work in small groups to make sense of the information available through the map and the data that they can access. Use the questions on the module webpage to guide students' exploration of the site.
- Use these questions to guide students' initial exploration:
 - *How many sensors are in your community? How many sensors are there around the world?* [This number grows daily, but there are over 20,000 sensors.]
 - *How is the air quality in your community today?*
 - *What information is available for each sensor?*
 - *How is air quality rated?*
 - *What questions does the information you are exploring raise?*



- Use these questions to push students further in their exploration.
 - *How frequently is the data captured?* [Data is collected every 5 seconds, then averaged in different ways.]
 - *Choose a single sensor. What information is available from that sensor?*
 - *What does the graph on a single sensor show?*
 - *What patterns do you see in the graph?*
- After small groups have had time to make sense of the data and download data from a sensor, ask the class to come together to share what they learned. Use the questions to guild a large group discussion, where groups learn from each other.
- Close the discussion with the central question of data science and project-based learning:
 - *What questions does the data raise?*
- Begin a list of key questions that the groups want to explore. It should be broad to start—the list will evolve and narrow throughout the project as students learn more about the data and tools. Keep the list present and visible in the classroom.

Warming Up with the Data

- Before diving into the Performance Tasks, use [Student Activity Sheet 1](#) to help students think about data and the data collection process. The questions on the activity sheet should promote the kind of thinking that is critical to building data acumen.
- This [Google Sheet](#) provides a sample of how students might analyze the data. It is a download of the two-minute measurements taken over a 24-hour period. This is the finest granularity that can be accessed through the PurpleAir map. One hour has 30 measurements, and one day of data consists of $30 \times 24 = 720$ measurements.
 - Asking *Where?* motivates the use of maps in Performance Task 2, when students look for geo-spatial patterns in the data.
 - Asking *When?* introduces students to the notion of measurements that are collected over time, and that have a natural ordering. The scatterplot should be familiar to students, but they might not be familiar with the line plot, a common way to represent temporal data. (See [Understanding scatterplots](#) for additional student support.) Both scatterplots and line plots can motivate the need for averaging to look for trends in time. Also, the variability in the measurements and the changes in air quality over the day are visually distinct with these plots.
 - Asking *How?* helps students think about the natural variability in the measurements. While a histogram will give a sense of the variation in the measurements, a histogram of all 720 measurements includes the change over the day in air quality and the variation due to the accuracy of the instrument. The three histograms in the Google Sheet make this point. There is one histogram for all 720 measurements in a day, one for the 60 measurements between midnight to 2AM, and another for measurements between 10:30 AM and 12:30 PM. For the 2-hour windows, the measurements are at most about 0.5 to 1 PM_{2.5} away from their center, compared to the large range of 7 PM_{2.5} for measurements over the course of the day. (See [Describing a data distribution](#) for additional student support.)



Performance Tasks

- Student groups should work on the performance tasks below, using the support in the Exploring air quality module online. They may also want to use the [Content Support](#) page as needed.
- Encourage students to work through the performance tasks in order, as they scaffold the complexity of students' analyses. The first performance task makes use of downloadable data from PurpleAir and spreadsheet technology. The second performance task makes use of two animations that begin to consolidate data from PurpleAir for students to look for trends in data. Finally, performance task 3 introduces students to Jupyter notebooks and the power of coding to explore questions in the air quality data.

Performance Task 1: Making sense of the data.

- In this performance task, students should work with a partner or in small groups to explore the data available on PurpleAir.
- Have students choose a sensor they are interested in to explore and then download data to analyze. In order to download the data, students will need to use the Sensor Data Download tool. This tool is visible when they hover over the "Get This Widget" text in the sensor information box
- Students may need support in downloading the file using spreadsheet technology depending on the technology they are using. (Excel, Googlesheets, etc.)
- As students analyze the AQI -PM2.5 data in their spreadsheets, encourage them to consider measures of center, variability, and range. Have students discuss the best visualization(s) to make sense of the data and be prepared to share their data.
- Refer students to the Content Support page and the [Understanding visual displays of information](#) page.

Performance Task 2: Looking at a year in the data.

- In this performance task, students use animations to explore the data over one year for a sensor of their choice. The first animation shows data from across the country for the years 2020 and 2021. The second animation allows students to zoom in on a few regions around the country.
- As students explore, ask:
 - *What patterns do you see in the data?*
 - *Why do you think those patterns exist?*
- Encourage students to research the area around the sensor to help make sense of the data.
- Ask students to share their observations and any reasons they suspect for your observations.

Performance Task 3: Comparing data from sensors.

- In this performance task, students are introduced to Jupyter notebooks and interactive programming environments.
- Have students watch the AQI Notebook Overview video to watch as a UC Berkeley Data Science student shares how to run a Jupyter notebook.
- Have students launch the Jupyter notebook and begin exploring using the notebooks.
- The Texas Air Quality – Widgets and Schools video can be used for additional support in accessing the tools within the Jupyter notebook.



- As students explore using the Jupyter notebook, ask them to look at data from regions they are interested in and compare the data to another region.
- Have students discuss ways to describe and display the data from the regions to a local council. Ask:
 - *What other questions do you want to investigate and why?*

Introducing Metacognitive Strategies

- Use the [Metacognitive strategies](#) to introduce students to tools and resources to help them think about their own thinking.
 - [Metacognition Tool](#): Students can use this tool as a reminder of the kinds of questions that prompt metacognitive thinking.
 - [Problem-Solving Tool](#): Students can use this tool to reflect on their progress, apply, strategies for persistence, and examine their own thinking as they work on challenging tasks.
 - [Self-Reflection Tool](#): After students have finished a task, they can use this tool to consider their approach and to reflect on their process and progress. Students can choose one or two of the prompts to reflect on.
- As students work on their projects, remind them to use these tools to monitor their work and reflect on their thinking.

Presentation Development

- After completing the performance tasks, student groups should have the tools and knowledge to address the questions they have chosen to investigate. Groups should decide on actions they want to take to answer these questions and how they want to present that information. Action steps may include a presentation to particular organizations or an informational pamphlet. Students should choose an action step based on their findings and areas of interest and prepare a presentation to the class.
- Share the activity sheets ([Presentation Development Tool](#), [Presentation Reflection](#), and [Presentation Rubric](#)) with students so that they can use these tools as they plan for their presentations.
- Encourage students to invite guests who fit the intended audience to attend the presentation of their work.

