AirBeam Lesson Guide

TEACHER GUIDE

Day 1

Note: Setup stations for measurements before class, but don't light any candles until students are ready to take measurements.

1. Tell students that for the new two days they are going to be collecting data with electronic devices called AirBeams that are paired with tablets (or smartphones).

2. Introduce the AirBeams and tablets to students by demonstrating how to turn on the devices and off, and how to connect them to the tablets (see "Using the AirBeam and AirCasting App")

3. Explain to students how the AirBeams work. Key points:
   - The AirBeams have a fan that pulls air into the device
   - There is an LED inside that shines a light on the air
   - The LED light is absorbed and scattered by the different sizes of PM
   - Sensors inside the AirBeam detect and measure the number of particles and their size by how much light is absorbed, and scattered

4. Divide the class into teams of four or more students depending on the number of instruments you have. Assigning roles to each member of the student team will help make sure all students are actively engaged. For Day 1, only roles 1, 2, and 4 are needed. For Day 2, all four roles will be needed. Each team member can be assigned one of the following roles:
   1) **AirBeam transporter**: makes sure the air beam is on and the air intake is clear and facing outwards. Stay within 10 feet of tablet.
   2) **Tablet carrier:** makes sure the tablet is connected, receiving and recording the data. Also takes photos of sources using tablet. Reads out the data for the group along the route.
   3) **Cartographer and timekeeper:** lead the team on agreed upon route. Identifies sources of pollution and makes notes on map
   4) **Data and note taker:** fill in the data table for # of sites agreed upon. Records observations.

5. Pass out AirBeams and tablets to each group. Make sure all group members know how to turn the AirBeam on and off, and how to pair it with the tablet. Remind students that the equipment is delicate and should be handled with care.

6. Pass out data collection sheets to students and review how they will collect data. The units of PM are $\mu g/m^3$. Explain to students how small a microgram is (one-millionth of a gram) and how big a cubic meter is.

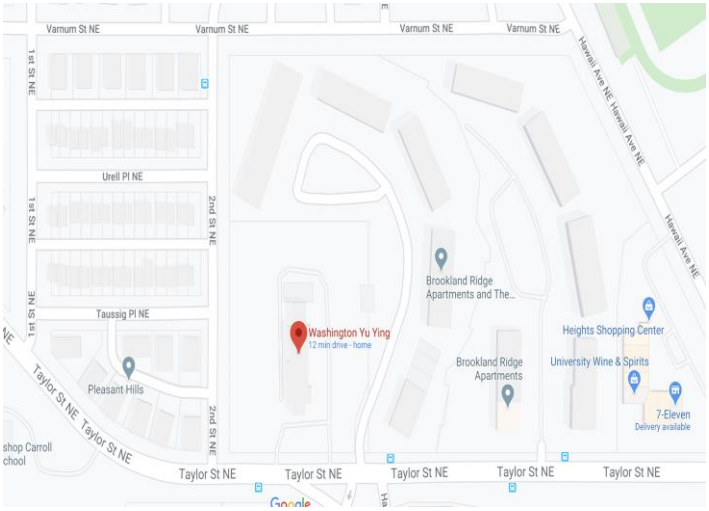
7. Finish setting up PM source stations. Possible stations include a candle, an air freshener (spray), chalk dust, incense, etc.

8. Have students rotate among the stations and collect data. As each team moves through the stations, they learn that commonly used items may release particulate matter. Have students switch roles at different stations so all students can practice using the AirBeam and using the AirCasting app on the tablet.

9. After the students have visited all the stations, have them return the AirBeams and tablets. Then have them review their data and answer the questions on their data sheets: What source emitted the most PM? Why do you think that is? What kind of PM was the most common? Why? Discuss answers with students afterwards. You can also ask additional follow up questions such as: what happened when you moved closer or farther from a source?

10. To prepare for the outdoor portion of the investigation, project a Google Map of the school community and/or pass out printed maps to students. Based on their warmup answers, and the research they have just completed, have students identify possible sources of PM on their school grounds or in the community. Common sources include the bus and car drop-offs, vents from the school (from an incinerator or HVAC system), or a busy street nearby.

11. Finally, have students develop an AirCasting route based on their understanding of where and when particle pollution might be elevated. Also consider where the pollution is going to be the lowest as a comparison point. Make sure students consider the time of day – will there be cars or buses idling out front? If not, can someone collect data when there are buses? You may have different classes or perhaps teams of students test air quality at different times of the day or in specific parts of the school grounds or community. Some students may agree to arrive at school early one day to test when the buses arrive in the morning or stay late in the afternoon when parents are picking up students. Pass out the "Measuring Particulate Matter in the School Community" data sheets to students, and have them draw or write their route on the sheet, with numbers showing where they will collect individual data.



Example map for planning AirCasting route

Day 2

1. Organize students into their groups, and make sure that all students know their assigned roles. If students will be traveling with a chaperone, have the chaperone introduce themselves to the students.

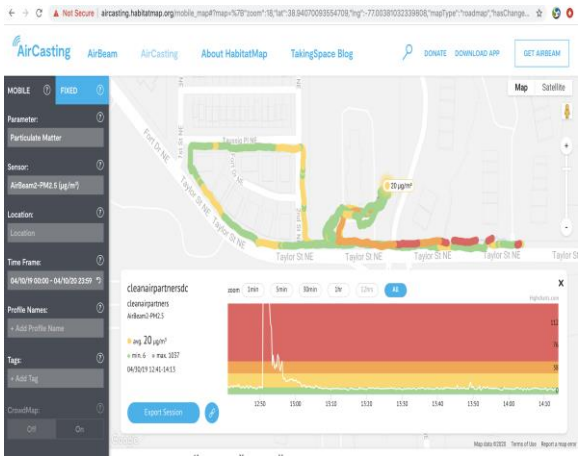
2. Make sure all student groups have their Measuring Particulate Matter in the School Community data sheets with their routes on them. Review what additional data students will collect while outdoors. They should use their various senses (sight, smell and hearing) and observe and note emission sources: ex: **mobile** sources such as moving cars, trucks, buses, a smoker AND **stationary** sources such as a vent, garage, nail salon. Note how close the source is to the sensor.

3. Hand out the AirBeams, tablets, and clipboards. Check to make sure all AirBeams and tablets are on and connected before going outside.

4. Take students outside to a central meeting location. If groups will be following different routes, make sure students and chaperones know what time they will meet back at the central location.

5. Students follow their agreed upon routes, collecting data as they go. When they have completed their routes, they return to the central meeting location.

6. When the student teams return to the classroom, have them upload the data to the AirCasting site (option crowdmap). If time permits, student teams should look at and analyze their data and be ready to share out their observation and results (otherwise this can wait until Day 3).



Sample data from the AirCasting website

7. Before the end of the class period, make sure to look up the PM2.5 levels for the area near the school. You can find this information by going to https://www.iqair.com/air-quality-map and using the map to find the nearest sensor. Be sure to record the PM2.5 level in $\mu g/m^3$ (not the AQI).

Day 3

1. Have students work with their groups to complete the analysis questions on their data sheets. Lead a short sensemaking discussion afterwards to clarify student thinking, especially around the idea of where the PM in the school community is coming from.

2. Project students' data from the AirCasting website, and discuss the data to clarify any questions they have.

3. Have student groups present the data they collected and share what they learned. Groups should share:
    - Where they went
    - What they found (ex. sources)
    - What their data was
    - What they learned from their data collection and analysis
    - Anything they would do differently next time

4. Have students complete the "Conclusions" section on their data sheets, and lead a short discussion afterwards to review conclusions.

5. The final assessment for this activity is the Claim-Evidence-Reasoning argument. You may have students do this in class or as a homework assignment. Especially if students are new to writing CERs, it is worthwhile to provide feedback on their responses and have them revise their responses to ensure that their final CER is high quality.

    Sample CER:

    - Claim: The air near the bus drop-off is the least healthy for people to breathe.
    - Evidence: The level of PM 2.5 near the bus drop-off was 42.5. This was the highest of all our measurements.
    - Reasoning: PM 2.5 can get into your lungs and your bloodstream, which can cause many different health problems. The EPA chart shows that the amount of PM 2.5 near the bus drop off was in the "unhealthy for sensitive groups" range which was the worst rating for all of our tests.