

Real-Time Air Quality Activity

Developed by: Stefani D. Hines, M.A., M.S., University of Arizona, Southwest Environmental Health Sciences Center (SWEHSC), Community Outreach & Education Program.

In partnership with: John King, SWEHSC; Beth Gorman & Karen Wilhelmsen, Pima County Department of Environmental Quality; Lee Comrie & Natalie Barnes, Pima Association of Governments.

Materials: Internet access
Excel (or other spread sheet application)
Large sheets of blank paper
Color markers
Maps of Tucson
Color Folders (for groups to organize materials)
Tape measures or yard sticks (for Introduction to Statistics)
Computer Diskettes (to save group work)

Objectives: Familiarize students with data collection and analysis techniques.
Increase awareness among students of local air quality issues and corresponding health effects.

Time Commitment: Class 1 - Activity Introduction: 1 hour
Class 2 - Introduction to Excel: 1 hour
Class 3 – (OPTIONAL) Introduction to Statistics: 1 hour
Class 4 – Guess & Know & Data Collection Practice: 1 hour
Classes 5+ - Data Collection

1st Week
(data entry) 30 minutes

2nd Week
(data entry) 30 minutes

3rd Week
(data entry) 30 minutes
(data compilation/report prep) 1 – 1.5 hours
(report to class) 30-45 minutes

Monthly (through a cold & warm season)
(data entry, compilation, & report) 2-3 hours per month

Background Knowledge

Needed: Introduction to common air pollutants (ozone, carbon monoxide, particulates 10 μ and 2.5 μ);

Grades: It is recommended that the students receive two grades, an individual and a group grade. The individual grade will be their notebooks and the group grade will be their presentation.

Project Overview:

Preparation

1. Prior to or in conjunction with this activity, you may want to have the students learn about common air pollutants and their health effects, as well as, basic statistics (basic statistics activity is also included in this material). Interactive online air quality activities and other air quality activities can be found at <http://swehsc.pharmacy.arizona.edu/coep/exercises.html> or <http://www.airinfnow.org>

Class 1 – Activity Introduction (1 hour)

2. Introduce the students to the Real-Time Air Quality Activity (Activity Introduction guidelines page 4).
3. Divide the students into the following groups and hand out student instruction sheets (Student Sheets Section):

Green Group: Location (minimum 3 students)

Red Group: Time (minimum 4 students)

Yellow Group: Health Effects (minimum 4 students)

Blue Group: Weather (minimum 8 students)

Brown Group: Visibility (minimum 4 students)

4. Have the students set up a color-coordinated notebook that includes the following:
 - Cover sheet
 - Vocabulary
 - “Introduction to Excel” instructions
 - “Statistics Activity” (if you do it with the class)
 - “Guess & Know” Sheet
 - “Group Details” for their assigned group

Class 2 –Introduction to Excel (1 hour)

5. Introduce students to Excel (guidelines page 7).

Class 3 – Introduction to Statistics (OPTIONAL) (1 Hour)

6. If your students are not already familiar with the basics of statistics (average, standard deviation), you may want to conduct this simple exercise.

Class 4 - Guess & Know (15 min) & Data Collection Practice (45 minutes)

7. Have the students do the Guess & Know activity (page 11 & Student Sheets Section). This serves as a pre-test, gets the students thinking about the issues, and gets them working together.
8. Have the students in the same groups work on near-by computers to do the “Data Collection Practice (page 12)” They need to get into the habit of helping each other out.

Subsequent Classes – Data Collection & Products

9. Begin data collection. In this activity a week is defined as Monday – Friday.

Products:

10. Students will give group summary presentations/reports at the end of weeks 2 and 4 and monthly thereafter.

Optional Products:

Students will provide “press releases” to their school or community to inform them of the current air quality and/or alert their audience when pollutant levels are high.

Students will present their final product (paper or brochure), summarizing their group results.

Optional Follow-up Activity

11. Follow up with an activity on how to take action and help control air pollution (www.airinfonow.org).

Activity Introduction – Teacher Notes

1. Inform the students that they are going to have the opportunity to monitor air pollution in their city (Tucson) and near their school over the next several months.

Points to include:

- a. (Optional) They can inform their community about current air quality levels, especially when pollution levels are high. This can help people who are sensitive to air pollution make decisions that could help save their life.
 - b. They are doing real research using real data.
 - c. The reason the monitoring time is so long is to see what happens to air pollution in hot and cold seasons.
2. They will be pulling real-time air quality data off the Internet and keeping track of that information so they can learn about air pollution in their community and the health effects of air pollution.
 3. Tell the students that they will be divided into groups each tracking something different and you will share what you find with your classmates, and the community. (OVERHEAD)

Green Group: Location

- Different parts of the city have varying concentrations of pollutants. This is because traffic and weather patterns differ according to location. This group will see if they can identify pollution trends according to location.

Red Group: Time

- Pollutant concentrations vary by time of day. This group will see if they can identify trends in pollution concentrations by time of day.

Yellow Group: Health Effects

- One of the reasons we care about air pollution is because it can adversely affect our health. People who have asthma or lung disease may be particularly susceptible to the effects of air pollution. This group will monitor the occurrences of asthma attacks at several schools throughout the district and see if there is any correlation with air pollution levels.

Blue Group: Weather-Internet

- Pollutant concentrations vary with weather conditions like temperature, wind speed and direction, humidity, and rainfall. This group will see if they can identify trends in pollutant concentrations

with changes in weather. They will monitor the weather conditions via the internet at weather stations in other locations in the city.

Brown Group: Visibility

- Air pollution can obscure our views and add a colored tint to the sky. This group will monitor the visibility from the sky-cam Internet camera. They will try to identify trends in visibility with respect to weather, type of pollution and concentration.

4. Students will regularly share their data with their classmates. (Optional) They can alert their school or community when air pollution levels are high. And at the end of the activity, they will summarize their findings in a paper (or some other product) that can be shared with the community.
5. Review the timeline with the students (OVERHEAD)
6. Define the following terms for the students (OVERHEAD & STUDENT HANDOUT):

Air Quality Index (AQI) – A scale developed by the EPA (Environmental Protection Agency) to report the levels of certain air pollutants, and their effects on human health.

Parts Per Million – A unit of measurement that describes the number of parts of something within a million parts of something else.

Carbon Monoxide – A toxic gas made from incomplete combustion (burning) of carbon-based materials like gasoline, coal, and methane (natural gas). The abbreviation for carbon monoxide is CO, which shows its chemical composition of one carbon atom attached to one oxygen atom.

PM 2.5 – Particulate matter that is very small, less than 2.5 microns in size. These particles are created by combustion, mostly from vehicles. Because they are so small, they can go deep inside the lungs.

PM 10 – Particulate matter that is “larger”, approximately 10 microns in size. These particles can include dust, pollen, and ash. They can irritate the upper respiratory system like the nose and upper lungs.

Micrograms – A unit of measurement that depicts very, very small quantities of a substance - 1/1,000,000 or 0.000001 of a gram.

Military Time – Time units that sequentially number the hours in a day from 0:00 (midnight) to 23:00(11 p.m.).

Ozone – A gas made up of three molecules of oxygen (O₃). In the upper atmosphere ozone protects the earth from ultra violet rays, but if ozone is created in the lower atmosphere (what we breathe) it can negatively affect plant and animal life.

7. Take the students through an virtual tour of the monitoring sites via the Internet <http://www.airinfnow.org> (or use the OVERHEAD).
8. Show the students the main website they will be working from (or use OVERHEAD of front page)

<http://swehsc.pharmacy.arizona.edu/coep/airexercise/>

- “Your Data” links take the students to the real-time air quality data.

Note: The “report main” page or “Index to Available Data Listings” shows the raw data in parts per million (ppm) and will be used by the Red Group.

Note: The “Reports list” or “Saved Reports” page shows the Air Quality Index numbers (AQI) and will be used by the Green, Blue, Yellow, and Brown Groups.

- “Your Spreadsheet” downloads the spreadsheet for each group.

9. Divide the students into groups, set up notebooks.

Notebook Contents:

- Cover sheet
- Vocabulary
- “Introduction to Excel” instructions
- “Statistics Activity” (if you do it w/the class)
- “Guess & Know” sheet
- “Group Details” for their assigned group

Introduction to Excel – Teacher Notes

It is recommended that the students have an opportunity to become familiar with Excel prior to starting their data collection. To do this, have the students download the Excel spreadsheet for the “Practice Spreadsheet”, insert one week’s worth of data, and then find the average, standard deviation, and create a graph. A student activity sheet is provided with instructions. (Student Sheets Section)

Step-by-Step Instructions:

- a. Tell students they will download pre-labeled Excel spreadsheets from the website <http://swehsc.pharmacy.arizona.edu/coep/airexercise>
- b. Explain that this is a practice exercise that gets them familiar with how to use Excel before they enter their “real data.”
- c. Remind the students that they will be using different spread sheets for their color groups.
- d. From the webpage, have them select the “Practice spreadsheet.” (More advanced students can set-up their spreadsheets from scratch.)
- e. Have the students type the following **Carbon Monoxide** data into the spread sheet (OVERHEAD):

Day	Date	Alvernon & 22 nd	Cherry & Glenn	Children’s Park	Craycroft & 22 nd	Downtown
1	1/27/01	22	15	16	15	20
2	1/28/01	15	3	6	6	8
3	1/29/01	19	14	12	11	26
4	1/30/01	19	22	15	12	25
5	1/31/01	24	18	12	15	27

- f. Point out that the average is calculated on the spreadsheet for a few examples. But for most of the locations they will have to calculate the average.
- g. To obtain the average click on the **f(x)** button at the top-center of the page ⇒ select AVERAGE ⇒ enter the first and last cell numbers you want to average separated by a colon. At the Children’s Park location that would be (E5:E9).

Note: If the average (or standard deviation functions have not been used recently, under the function category select “statistical.”)

- h. To obtain the standard deviation click on the **f(x)** ⇒ select STDEV ⇒ enter the first and last cell numbers you want to average separated by a colon. At the Children’s Park location that would be (E5:E9).

Introduction to Excel – Cont'd

CREATE A GRAPH

- A. Highlight C10:G10 (averages)
- B. Click on the Chart icon or go to “Insert” → “Chart”
- C. Under “Chart Type” highlight column, select “Next”
- D. Check to make sure the “Data Range” has the correct squares (the ones you highlighted). Leave “Series in rows” selected.
- E. Click on the “Series” tab (top of gray box).
- F. Click in the box “Category (X) axis labels” and then highlight your locations. (You should see the X axis labels change from 1, 2, 3... to Alvernon & 22nd, Cherry & Glenn, or whatever your locations are.)
- G. In the “Name” box type in “Week in January,” select “Next.”
- H. In the “Chart Title” type in the title “Carbon Monoxide by Location.”
- I. In the “Category (X) Axis” type in “Location.”
- J. In the “Category (Y) Axis” type in “Air Quality Index.”
- K. Save chart “As New Sheet.” And label “Chart Example.”
- L. Select “finish.”
- M. Now we are going to add error bars.
- N. Double click on one of the bars.
- O. A window titled “Format Data Series” should come up.
- P. Click on the tab titled “Y Error Bars.”
- Q. Select “Display Both.”
- R. Under “Error Amount” select “Custom” and click in the “+” field.
- S. Now go back to the “Carbon Monoxide” spread sheet by clicking on the lower left tab.
- T. Highlight the cells C11:G11 (standard deviation.).
- U. Go back to the chart. Under “Error Amount” select “Custom” and click in the “-” field.
- V. Again, go back to the “Carbon Monoxide” spread sheet and highlight the cells C11:G11 (standard deviation.). You should see the error bars on the columns.

(Example of the chart is in OVERHEADS and on the student instructions)

Introduction to Statistics Activity – Teacher Notes

1. Hand out the “Introduction to Statistics Activity” student sheet.
2. Measure the height of each person in the class. (Be sure to measure the height in one unit, such as *only* inches or *only* meters, not feet and inches)
3. Have each student write down the individual heights on their sheet called “Introduction to Statistics Activity.”
4. Place a mark for each individual height on the “Height Statistics Overhead” (OVERHEAD).
5. Explain to the students that what they see on the overhead is called a bell curve. The bell curve is a visual representation of the average height (the peak of the curve) and the deviation from the average (the outer edges).
6. Using calculators have the students find the average of height in the class. How closely does their average match the peak of the bell curve?
7. Have the students calculate the deviation of a few samples using the following formula: (This is so they can see how the standard deviation is actually calculated)

$$S = \sqrt{\frac{\sum(x_i - x)^2}{n-1}}$$

where x_i is an individual result, x is the mean, and n is sample number.

The table below is on the student “Introduction to Statistics Activity” to guide them through the process step-by-step.

Sample #	Height (Inches or meters)	Deviation (measured value – average) OR (column 2 – average)	Deviation Squared (deviation X deviation) OR (column 3) ²
1			
2			
3			
	Sum =		Sum of deviations =
	Average =		

Standard Deviation (sum of deviations/n-1):

You may want to ask the students what happens to the standard deviation when n gets bigger and then ask them if this is good or bad? Having a small standard deviation is good because you can better tell if your result is different from the norm.

They will see this happen when they find the Standard Deviation for all of the heights measured in the class (using Excel).

8. Have the students enter the class heights into one column of an Excel spreadsheet.

9. Have them find the Average and the Standard Deviation using Excel.

10. How closely does the Standard Deviation match the outer edges of the bell curve?

The Standard Deviation will typically not encompass the outer edges of the bell curve, but it will encompass the majority of the samples. This is because the Standard Deviation tells you that 68% of the time subsequent samples will fall between those numbers.

11. Explain that scientists need to know the average and the deviation of their data in order to tell if something is different. For example, say a scientist was studying the heights of people around the world. The working hypothesis was that people in China are shorter than people in the U.S. If the scientist measured the height of 10,000 people in the U.S. and 10,000 people in China and found that the average U.S. height was $5'10'' \pm 1''$ and the average Chinese height was $5'9'' \pm 1''$ the scientist would have to say there was no significant difference. This is because both numbers overlap (U.S. $5'9'' - 5'11''$, China $5'8'' - 5'10''$). But if the deviation was only $\frac{1}{4}''$ then there would be a significant height difference between the two populations.

Guess & Know Activity– Teacher Notes

1. After the students set up their group notebooks, have them find the page titled “Guess & Know”.
2. Explain that they will work together as a group fill out the “Guess & Know” sheet.
3. The students will answer each question or address a topic. If they are guessing the answer or *think* they have the answer, but are uncertain, then they will write their answer in the “Guess” column. If they are certain about their facts/answer, then they will write it in the “Know” column.
4. The students will also write a hypothesis (an educated guess) about:

How the weather affects a particular pollutant (such as temperature, wind, humidity)

How pollution levels vary throughout the day.

How pollution levels vary at different locations within the city (such as downtown, freeway, North, South, East, West)
5. You can use this activity as a pre-test, and have them do it again at points throughout the entire Real-time Data Collection Activity (for example half-way through and at the end).

Data Collection Practice – Teacher Notes

This is the first real data collection for the students, but it is assigned a separate name and time frame because it takes practice before the students get the hang of the process. This is a time for “flailing” and lots of questions...Don’t worry after a few times of entering data they will do it diligently on their own!

1. Have the students break up into their color groups and get their individual folders.
2. Tell them they will be following the instructions on the “Group Details” sheets.
3. Have the students read the instructions.
4. The students need to select or be assigned their individual roles (listed on “Group Details” sheets).
5. Have the students go to <http://swehsc.pharmacy.arizona.edu/coep/airexercise> and download “Your Spreadsheet” for their color group. **EACH STUDENT WILL HAVE HIS/HER OWN SPREADSHEET.**
6. Provide instructions about where they should save the file.
7. Have the students go back to the website and select the link to their data.
8. Have the students record the data for yesterday, or the previous few days (how they access this data will vary between groups. Specific instructions are provided on the “Group Details” sheets.)
9. Have the students enter the dates and data into their spreadsheet.
10. Have the students save their data!

TIPS:

- Have the groups work at side-by-side computers.
- Encourage the group to help each other if they have questions (typically 1 or 2 students understand what to do).
- Students who help other students need to remember that the person they are helping will have a different role & collect different data (e.g. the ozone person has to collect ozone data not carbon monoxide).
- Show the students that there are STEP-BY-STEP instructions in their folders! (Otherwise they may ask for help without reading the instructions).