Middle Level Science

Is Air Quality in the Index?

Objectives:
- Make predictions and explanations based from evidence.
- Identify sources of air pollution that affect air quality.
- Interpret and apply the Air Quality Index.
- Have the desire to share Air Quality information with others.

5-8 NSES Standards:
- Standard A: Inquiry
- Standard D: Structure of Earth Systems
- Standard E: Science and Technology
- Standard F: Personal Health, Population, Resources, Environmental and Natural Hazards, Risks and Benefits, Science and Technology in Society

9-12 NSES Standards:
- Standard A: Inquiry
- Standard D: Geochemical Cycles, Origin and Evolution of the Earth System
- Standard E: Science and Technology
- Standard F: Personal and Community Health, Environmental Quality, Natural and Human Induced Hazards, Science and Technology in Local, National, and Global Challenges

Materials:
- Air Quality Index Card Sets
- Computers with Internet Access
- Assorted Worksheets

Prior Knowledge:
- Fossil Fuels, Renewable vs. Nonrenewable Resources, Energy Use, Energy Alternatives
- 7 Criteria Pollutants and NAAQS Standards

Engage: Hang a warning sign at the entry of the classroom. It should read, "The air quality index of this classroom is rated as unhealthy for sensitive groups." Ask the students what they think the sign means? What do students think of when they hear the words air quality? What is the quality of the air in the place where they live?

Explore: Students will receive a packet of cards. These cards are formed by cutting apart the Air Quality Index Chart (attached in Student Activities). Each card has either a number range from the Air Quality Index, a verbal descriptor of the air quality, or the color associated with the index. Upon receiving the cards the teacher will instruct the students to organize them into a

chart which they will record in their notebooks. For further though, have the students explain why they organized their charts in the manner that they did in their notebooks as well.

Explain: This chart will be the springboard to begin the discussion of the Air Quality Index. What types of charts did the students develop? Why did they place the cards in those patterns? How does this compare with other indexes they may have seen? Place on the overhead the correct chart and see how close they have come. This is called the Air Quality Index. The EPA developed this chart to determine the 'cleanliness' of the air.

Air Quality Index

Color	AQI Number	Description
Green	0-50	Good
Yellow	51-100	Moderate
Orange	101-150	Unhealthy for Sensitive Groups
Red	151-200	Unhealthy
Purple	201-300	Very Unhealthy
Maroon	301-500	Hazardous

Action
Everyone can enjoy the Air**.**
Almost everyone (except extra sensitive people) can spend unlimited amount of time outside.
Sensitive groups (active kids, people with asthma, respiratory diseases, or allergies) should limit their time outside. Everyone should be advised to their breathing conditions when outside.
Sensitive groups should spend very little time outside. Everyone else should limit their time outside.
Sensitive groups should not spend any time outside. Everyone else should spend very little time outside.
No one should be outside!

In groups of three, students will brainstorm and record possible answers to the following questions. A discussion of the material will follow. (See Attached Air Quality Questions Worksheet and Teacher Notes)
1. How can dirty air make you sick?
2. How can you tell if the air is clean or dirty?
3. What are some pollutants?
4. What is a sensitive group?
5. How can you tell if air pollution is affecting me?
6. So if the AQI is orange or worse, do you have to stay inside all day?
7. What can you do to lower your risk from air pollution?
8. How can you lower pollution?

The teacher will then walk the students through a practice forecast. Using the information on the http://airnow.gov/ website the teacher will model how to read and interpret the map using the Air Quality Index. The students will complete a worksheet (See Attached Air Quality Broadcast Wkst. and Teacher Notes) in which they fill in the date, location, color, numbers, words, causes, and action that should be taken.

For Advanced Students:
The Air Quality Index uses measurements of 6 of the 7 criteria pollutants. Students will have already learned about these in the previous lesson. They will use these criteria pollutants in completing the worksheet entitled, How Does that Air Quality Index Work? The worksheet explains how using the NAAQS you can calculate the Air Quality Index number. (See Attached How Does that Air Quality Index Work? and Teacher Notes)

Elaborate:
The students will complete a worksheet (See Attached Air Quality Broadcast Wkst. and Teacher Notes) in which they fill in the date, location, color, numbers, words, causes, and action that should be taken. They should use their class notes and in class example to best complete this. They will then prepare a broadcast to present to their peers on the daily announcements. This can be done for your school city, a near-by city, or a vacation report. Be sure to review the evaluation rubric with the students for the project.

For Advanced Students:
The students will complete a worksheet (See Attached Air Quality Forecast Wkst. and Teacher Notes) in which they will compute the air quality index number for a given set of data. There is a sample problem at the top of the worksheet, which can be completed as a class. Assign students into groups of 3 or 4. Give each group a portion of the forecast data (See Attached Forecast Data Sheet and Teacher Notes) to use as they complete the forecast data portion of the worksheet. These students should then prepare an air quality forecast in which they will present the air quality index number, color, words, and action for the day. This data will then be presented to the class as an air quality forecast. There is an evaluation rubric for the students for the project.

Evaluate:
Evaluation is occurring constantly throughout the lesson. Informal assessment can occur while the teacher is leading class discussion. More formal assessment can occur through the correction of worksheets. The Air Quality Broadcasts can be graded using the attached rubrics.

Student Activity Sheets

Color	AQI Number	Description
GREEN	0 to 50	Good
YELLOW	51 to 100	Moderate
ORANGE	101 to 150	Unhealthy for Sensitive Groups
RED	151 to 200	Unhealthy
PURPLE	201 to 300	Very Unhealthy
MAROON	301 to 500	Hazardous

Action
Everyone can enjoy the Air.
Almost everyone (except extra sensitive people) can spend unlimited amount of time outside.
Sensitive groups (active kids, people with asthma, respiratory diseases, or allergies) should limit their time outside. Everyone should be advised to their breathing conditions when outside.

Sensitive groups should spend very little time outside. Everyone else should limit their time outside.
Sensitive groups should not spend any time outside. Everyone else should spend very little time outside.
No one should be outside!

Science- Air Quality Questions   Name: _____

1. How can dirty air make you sick?

2. How can you tell if the air is clean or dirty?

3. What are some pollutants?

4. What is a sensitive group?

5. How can you tell if air pollution is affecting you?

6. So if the AQI is orange or worse, do you have to stay inside all day?

7. What can you do to lower your risk from air pollution?

8. How can you lower pollution?

So How Does that Air Quality Index Work?

The Air Quality Index (AQI) is actually the percent of the NAAQS standard that is present in the atmosphere. To figure your percent on a test you take your score and divide by the amount possible then multiply by 100. You follow the same procedure when calculating the Air Quality Index. Take the amount of the pollutant in the atmosphere and divide by the NAAQS standard for that pollutant then multiply by 100. This number is the air quality index number. The Air Quality Index for a certain location is given by examining the percentages for the 6 criteria pollutants and selecting the highest one. This data is then shared with the public.

Air Quality Index = Pollutant Amount / Standard Amount x 100

1. Over Chicago today there are 12 ppm of Carbon Monoxide. What is the AQI for Chicago?

2. What words and color are associated with this number?

3. What types of people will this effect?

4. In Dubuque the ozone levels are 0.02 ppm. What is the AQI for Dubuque?

5. What words or colors are associated with this number?

6. What type of effect would this have on your day?

7. In Los Angeles the Nitrogen Dioxide level is 0.12 ppm. What is the AQI for Los Angeles?

8. What implications will this have for the city?

Air Quality Broadcast   **Name: _____**

Group Members: _____, _____,

_____, _____

In Class Example:

- *State: _____*

    o *Dates of Forecast: _____*

    o *Number of locations listed: _____*

    o *Location #1: _____*

        ▪ *Date: _____*

            • *Color: _____*

            • *Words: _____*

            • *Due to: _____*

            • *Action for the day: _____*

            _____

            _____

Directions:
1. **Log on. Go to http://airnow.gov/**
2. **Click on *Local Forecasts and Conditions*.**
3. **Click on the state. Make sure your state has at least 2 locations with information.**
4. **Complete the following worksheet. Utilize other class notes for the most accurate information.**
5. **Prepare an Air Quality Broadcast for the nearest city to your school or a location provided by the teacher.**
    a. **You will then present your Air Quality forecast for the school announcements the next morning.**
    b. **More credit will be given to groups with visuals, humor, eye contact, originality, and enthusiasm.**

- State: _____

    o Dates of Forecast: _____

    o Number of locations listed: _____

    o Location #1: _____

        ▪ Date: _____

            • Color: _____

            • Words: _____

- Due to: _____
- Action for the day: _____

  _____

  _____

  - Date: _____
    - Color: _____
    - Words: _____
    - Due to: _____
    - Action for the day: _____

      _____

      _____

- Location #2: _____
  - Date: _____
    - Color: _____
    - Words: _____
    - Due to: _____
    - Action for the day: _____

      _____

      _____

  - Date: _____
    - Color: _____
    - Words: _____
    - Due to: _____
    - Action for the day: _____

      _____

      _____

- What is Air Quality and why should your classmates care?
  - _____

    _____

- List 3 ways that you and your community can do to improve Air Quality.
  - _____
  - _____
  - _____

- **BROADCAST INFOMRATION!!!**
  - Location: _____
    - Date: _____
      - Color: _____
      - Words: _____
      - Due to: _____
      - Action for the day: _____

        _____

        _____

Air Quality Forecast

Sample Data:

Location: Anytown, USA

<u>Criteria Pollutants Measured</u>   <u>Calculated Air Quality Index Number</u>

Ozone 0.06 ppm   _____

Sulfur Oxides (24 Hour) 0.12   _____

Carbon Monoxide 8 ppm   _____

Color: _____

Words: _____

Due to: _____

Action for the day: _____

_____

_____

Forecast Data:

Location:

<u>Criteria Pollutants Measured</u>   <u>Calculated Air Quality Index Number</u>

_____   _____

_____   _____

_____   _____

Color: _____

Words: _____

Due to: _____

Action for the day: _____

_____

_____

Now using the forecast data prepare an Air Quality Broadcast for your location. This broadcast
will be presented to an audience. Make sure to use visuals, eye contact, enthusiasm, and
creativity.

Forecast Data for Different Groups

Houston, Texas
Carbon Monoxide 6 ppm
Ozone 0.14 ppm
Sulfur Oxides (24 hour) 0.09 ppm

Dubuque, Iowa
Particulate Matter Less Than 10 Micrometers (24 hour) 25 µg/m^3
Ozone 0.03 ppm
Nitrogen Dioxide 0.01 ppm

Chicago, Illinois
Carbon Monoxide 12 ppm
Ozone 0.07 ppm
Particulate Matter Less Than 2.5 Micrometers (24 hour) 35 µg/m^3

Lancaster, Pennsylvania
Nitrogen Dioxide 0.04 ppm
Sulfur Oxides (24 Hour) .16 ppm
Particulate Matter Less Than 10 Micrometers (24 hour) 30 µg/m^3

Los Angeles, California
Particulate Matter Less Than 2.5 Micrometers (24 hour) 60 µg/m^3
Carbon Monoxide 15 ppm
Ozone 0.15 ppm

Orlando, Florida
Particulate Matter Less Than 10 Micrometers (24 hour) 93 µg/m^3
Ozone 0.02 ppm
Particulate Matter Less Than 2.5 Micrometers (24 hour) 27 µg/m^3

Rubric for the Air Quality Broadcast

Criteria	Excellent	Average	Poor
Inclusion of Background information (Place, dates, etc.)	5	3	1
Forecast Details (color, words, due to, action)	5	3	1
Use of Class Time in Preparation for Broadcast	5	3	1
Use of Visuals	5	3	1
Delivery (Volume, Eye Contact, Posture, etc.)	5	3	1
Creativity	5	3	1

Teacher Notes

TEACHER NOTES

Explain - Middle School - Air Quality Questions

1. How can dirty air make you sick?

    a. Dirty air goes into your lungs and makes it hard to breathe. You may cough and feel strange. If you are breathing heavy from exercising, more of this air will go into your lungs making it even harder to breath.

2. How can you tell if the air is clean or dirty?

    a. Sometimes you can tell by sight and smell. The air may look hazy or brown, like in the pictures you saw of New York City. The air may also smell, like you are behind a tractor trailer on the highway or when your windows are open as you pass by a farm.

    b. But there are times when the air is dirty and it doesn't smell or look bad. This is why the Environmental Protection Agency developed the Air Quality Index, which tells you how good or bad the air is on a given day.

3. What are some pollutants?

    a. Pollutants are things that cause the air to become dirty. The two main pollutants that are recorded on the Air Quality Index are Ozone and Particulate Matter.

        i. Ozone is ONLY good when it is way high up in the atmosphere, but when it is close to the ground we breathe it in. This is BAD. Ozone (O_3) is formed in the lower atmosphere from car exhaust and industrial air pollution. Breathing this ozone causes you to cough and the lining of your lungs to become "sun burned", becoming red and puffy.

    ii. Particulate Matter is dust and soot that is in the air. This gets in the air from many places such as driving down a dirt road, manufacturing companies, and burning. Particulate matter causes the air to look hazy. Particulate Matter can make you cough and get more colds.

4. What is a sensitive group?

    a. Sensitive groups are people who are more susceptible to getting sick from air pollutants. The following are sensitive groups: people with asthma or allergies, children (because kids are outside more and their lungs are still developing), and the elderly.

5. How can you tell if air pollution is affecting you?

    a. You will have problems breathing. These problems include coughing, chest tightness, and discomfort when you breathe. People with asthma may experience wheezing and should follow their doctors' precautions when pollution levels are elevated.

6. So if the AQI is orange or worse, do you have to stay inside all day?

    a. No, depending on your sensitivity you may want to limit your activities. Otherwise you may simply experience the affects of air pollution. Being outside when air pollution is high is just like any other risk in that you have to limit your exposure.

7. What can you do to lower your risk from air pollution?

    a. Only spend extended time outside when pollution levels are low. If you are outside when levels are elevated, limit exercising or any other activity that would increase breathing. Take note of breathing problems or restrictions.

8. How can you lower pollution?

    a. Limit use of vehicles: carpool, public transportation, walk/bike

    b. Upkeep of vehicles: do not fuel up in the middle of the day, keep tires at desired pressure, and keep vehicles in good running condition.

    c. Properly dispose of waste, and recycle.

So How Does that Air Quality Index Thing Work?

The Air Quality Index (AQI) is actually the percent of the NAAQS standard that is present in the atmosphere. To figure your percent on a test you take your score and divide by the amount possible then multiply by 100. You follow the same procedure when calculating the Air Quality Index. Take the amount of the pollutant in the atmosphere and divide by the NAAQS standard for that pollutant then multiply by 100. This number is the air quality index number. The Air Quality Index for a certain location is given by examining the percentages for the 6 criteria pollutants and selecting the highest one. This data is then shared with the public.

Air Quality Index = Pollutant Amount / Standard Amount x 100

1. Over Chicago today there are 12 ppm of Carbon Monoxide. What is the AQI for Chicago?

    a. *12 / 9 * 100 = 133*

2. What words and color are associated with this number?

    a. *Unhealthy for Sensitive Groups, Orange*

3. What types of people will this effect?

    a. *People with asthma, young children, elderly*

4. In Dubuque the ozone levels are 0.02 ppm. What is the AQI for Dubuque?

    a. *0.02 / 0.08 * 100 = 25*

5. What words or colors are associated with this number?

    a. *Good, Green*

6. What type of effect would this have on your day?

    a. *None! It's a great day!*

7. In Los Angeles the Nitrogen Dioxide level is 0.12 ppm. What is the AQI for Los Angeles?

    a. *0.12 / 0.053 * 100 = 226*

8. What implications will this have for the city?
    a. *This is a very unhealthy rating. People in this area should limit their outdoor activities.*

TEACHER NOTES

Air Quality Broadcast

Depending class size and computer availability, divide the class into groups of 4. Show the student via an LCD projector the example. Texas is a good state to choose because there are usually air quality issues there.

The Broadcast is intended to be delivered on the school's TV morning announcements. Because of this, different groups will be gathering and preparing their Broadcasts at various times. This takes additional planning. Another option would be to have them prepare broadcasts from favorite vacation spots to the class.

Note for the airnow.gov website*: the 'Local Forecasts and Conditions' button is located on the horizontal green menu bar.*

In Class Example:
- State: *Texas*
    - Dates of Forecast: *June 14, 2006 – June 15, 2006*
    - Number of locations listed: *19*
    - Location #1*: Dallas / Ft.Worth, Texas*
        - Date*: June 14, 2006*
            - Color*: Red*
            - Words: *Unhealthy*
            - Due to: *Ozone*
            - Action for the day*: Sensitive groups should spend very little time outside. Everyone else should limit their time outside.*

TEACHER NOTES

Elaborate-High School-Air Quality Forecast

Sample Data:

Location: Anytown, USA

Criteria Pollutants Measured	Calculated Air Quality Index Number
Ozone 0.06 ppm	$0.06 / 0.08 * 100 = 75$
Sulfur Oxides (24 Hour) 0.12	$0.12 / 0.14 * 100 = 86$
Carbon Monoxide 8 ppm	$8 / 9 * 100 = 89$

Color: *Yellow*

Words: *Moderate*

Due to: *Carbon Monoxide*

Action for the day: *Everyone can be outdoors except those who are extra sensitive.*

Forecast Data:

Divide the students into groups of three or four and give each group one of the cities with the forecast data. The group should then record their information on their lab sheet along with calculating the air quality index number. They should then write a forecast for the day including color, words, why the index is that color, and what should be the action for the day. These forecasts will be presented to the class. Encourage the students to use visual aids, creativity, humor, and enthusiasm. They approximate time for these presentations should be about 2-3 minutes.

Location:

Criteria Pollutants Measured	Calculated Air Quality Index Number
_____	_____
_____	_____
_____	_____

Color: _____

Words: _____

Due to: _____

Action for the day: _____

_____

_____

_____

Now using the forecast data prepare an Air Quality Broadcast for your location. This broadcast will be presented to an audience. Make sure to use visuals, eye contact, enthusiasm, and creativity.

TEACHER NOTES

Elaboration - Forecast Data for Different Groups

Give each group one of the following cities along with the corresponding pollutant data. The students should then use this information to complete the forecast portion of their worksheet and develop a forecast to present to the class. See the Air Quality Forecast Sheet for additional teacher notes.

Houston, Texas
Carbon Monoxide 6 ppm
Ozone 0.14 ppm
Sulfur Oxides (24 hour) 0.09 ppm

Location: *Houston*

Criteria Pollutants Measured	Calculated Air Quality Index Number
Carbon Monoxide 6 ppm	*6 / 9 * 100 = 67*
Ozone 0.14 ppm	*.14 / .08 * 100 = 175*
Sulfur Oxides (24 hour) 0.09 ppm	*.09 / .14 * 100 = 63*

Color: *Red*

Words: *Unhealthy*

Due to: *Ozone*

Action for the day: *Sensitive groups should spend as little time as possible outside, while everyone else should limit their time outdoors.*

Dubuque, Iowa
Particulate Matter Less Than 10 Micrometers (24 hour) 25 $\mu g/m^3$
Ozone 0.03 ppm
Nitrogen Dioxide 0.01 ppm

Location: *Dubuque*

Criteria Pollutants Measured	Calculated Air Quality Index Number
Particulate Matter Less Than 10 Micrometers (24 hour) 25 $\mu g/m^3$	*25 / 150 * 100 = 17*
Ozone 0.03 ppm	*.03 / .08 * 100 = 37.5*
Nitrogen Dioxide 0.01 ppm	*.01 / .053 * 100 = 19*

Color: *Green*

Words: *Good*

Due to: *Ozone*

Action for the day: *Enjoy the day outside!*

<div align="center">

Chicago, Illinois

Carbon Monoxide 12 ppm

Ozone 0.07 ppm

Particulate Matter Less Than 2.5 Micrometers (24 hour) 35 µg/m^3

</div>

Location: *Chicago, Illinois*

Criteria Pollutants Measured   Calculated Air Quality Index Number
Carbon Monoxide 12 ppm   *12 / 9 * 100 = 133*
Ozone 0.07 ppm   *.07 / .08 * 100 = 87.5*
*Particulate Matter Less Than 2.5 Micrometers (24 hour) 35 µg/m^3 35 / 65 * 100 = 54*

Color: *Orange*

Words: *Unhealthy for Sensitive Groups*

Due to: *Carbon Monoxide*

Action for the day: *Sensitive groups should limit their time outside and everyone should be aware of the breathing while outside today.*

<div align="center">

Lancaster, Pennsylvania

Nitrogen Dioxide 0.04 ppm

Sulfur Oxides (24 Hour) .16 ppm

Particulate Matter Less Than 10 Micrometers (24 hour) 30 µg/m^3

</div>

Location: *Lancaster, Pennsylvania*

Criteria Pollutants Measured   Calculated Air Quality Index Number

Nitrogen Dioxide 0.04 ppm   *.04 / .053 * 100 = 75*
Sulfur Oxides (24 Hour) .16 ppm   *.16 / .14 * 100 = 114*
*Particulate Matter Less Than 10 Micrometers (24 hour) 30 µg/m^3 30 / 150 * 100 = 20*

Color: *Orange*

Words: *Unhealthy for Sensitive Groups*

Due to: *Sulfur Oxides*

Action for the day: *Sensitive groups should limit their time outside and everyone should be aware of the breathing while outside today.*

Los Angeles, California
Particulate Matter Less Than 2.5 Micrometers (24 hour) 60 µg/m³
Carbon Monoxide 15 ppm
Ozone 0.15 ppm

Location: *Los Angeles, CA*

Criteria Pollutants Measured   Calculated Air Quality Index Number
Particulate Matter Less Than 2.5 Micrometers (24 hour) 60 µg/m³   *60 / 65 * 100 = 92*
Carbon Monoxide 15 ppm   *15 / 9 * 100 = 167*
Ozone 0.15 ppm   *.15 / .08 * 100 = 187.5*

Color: *Red*

Words: *Unhealthy*

Due to: *Ozone*

Action for the day: *Sensitive groups should spend very little time outside while everyone else should limit their time outside.*

Orlando, Florida
Particulate Matter Less Than 10 Micrometers (24 hour) 50 µg/m³
Ozone 0.02 ppm
Particulate Matter Less Than 2.5 Micrometers (24 hour) 27 µg/m³

Location: *Orlando, Florida*

Criteria Pollutants Measured   Calculated Air Quality Index Number
Particulate Matter Less Than 10 Micrometers (24 hour) 50 µg/m³   *93 / 150 * 100 = 62*
Ozone 0.02 ppm   *.02 / .08 * 100 = 25*
*Particulate Matter Less Than 2.5 Micrometers (24 hour) 27 µg/m³ 27 / 65 * 100 = 41.5*

Color: *Yellow*

Words: *Moderate*

Due to: *Particulates Less than 10 Micrometers*

Action for the day: *Almost everyone, except extra sensitive people can spend unlimited time outside.*