

LESSON:

Mapping the Air in Your School

Summary: Students read the article “Beyond the Bench: Mapping the Air in Public Schools.” Then students measure temperature and relative humidity in different rooms in their school and compare their results to the results reported in the article.

EHP Article: “Beyond the Bench: Mapping the Air in Public Schools”
EHP Student Edition, August 2005, p. A308
<http://ehp.niehs.nih.gov/docs/2005/113-5/niehsnews.html#mapp>

Objectives: By the end of this lesson students should be able to:

1. explain how indoor air temperature and relative humidity can have an impact on building occupants’ comfort and health;
2. define and measure relative humidity and temperature; and
3. interpret indoor air temperature and relative humidity measurement results as an indicator of indoor air quality problems.

Class Time: 1 hour (or more if data are collected over several days)

Grade Level: 9–12

Subjects Addressed: Biology, Chemistry, General Science, Physical Science, Environmental Science

►Prepping the Lesson (15 minutes)

INSTRUCTIONS:

1. Obtain a class set of *EHP Student Edition*, August 2005, or download “Beyond the Bench: Mapping the Air in Public Schools” at <http://ehp.niehs.nih.gov/docs/2005/113-5/niehsnews.html#mapp> and make copies.
2. Make copies of the Student Instructions.
3. Assemble the materials needed for the laboratory activity.
4. Review the article and lesson.
5. Obtain permission as needed from school and/or district administrators to conduct the investigation. You may want to discuss whether they are aware of any issues in the school and/or any actions they are prepared to take if issues are found.
6. Decide how you want to conduct the relative humidity and temperature measurements as well as inspect the rooms under investigation. You will need to decide what rooms you will measure and when. You may make multiple measurements during the day and/or take a number of measurements over several days in as many rooms as practical. The more measurements you make, the more likely it is that the measurements will be representative of the conditions in the rooms. If you have limited ability to do other classrooms, you may focus all of your measurements in your own classroom and perhaps combine the results made throughout the day by multiple classes. If you do not have access to sling psychrometers or other devices to measure relative humidity, you may limit your study to measuring temperature only.

MATERIALS:

Per Student

- 1 copy of *EHP Student Edition*, August 2005, or 1 copy of “Beyond the Bench: Mapping the Air in Public Schools”

Per Group

- 1 copy of the Student Instructions
- 1 thermometer
- 1 sling psychrometer and psychrometric chart, table, or other approach to determine the relative humidity, or other device to measure relative humidity
- 1 watch



- graph paper to make a floor plan of your school building (one group only)
- 1 overhead transparency for projecting final floor plan with measurements

VOCABULARY:

- geographic information system (GIS)
- relative humidity

BACKGROUND INFORMATION:

How a building's indoor air quality (IAQ) impacts on its occupants' comfort and health is complex and not completely understood. There are numerous factors that can affect IAQ, such as human activity within the building, the building's construction materials, and the types of heating, ventilation, and air conditioning (HVAC) systems in a building. Common human activities that can affect IAQ include the use of copiers, pesticides, and cleaning products. Building materials and the HVAC system can vary with the age of the structure. Newer buildings may have significant toxic offgassing from carpets, paint, and particleboard, but also may have better air filtering systems. Older buildings may have cellulose wallboard (which is susceptible to mold), asbestos ceiling tiles, lead-paint dust, and/or leaky ventilation systems. The outdoor environment can also significantly affect IAQ. Dry, windy climates increase dust. Warm, humid climates have more insects, pollen, and mold.

Poor IAQ can certainly affect occupants' health and comfort levels—sneezing and runny noses are uncomfortable and a sign of adverse health effects. Room temperature and humidity, one focus of this lesson, can both affect immediate physical comfort and influence IAQ. There is a relationship between temperature, humidity, IAQ, and comfort. Comfort relates primarily to the temperature, the amount of clothing being worn, relative humidity, and air movement. There is no one temperature where everyone feels comfortable, but the typical range of acceptable indoor air temperatures is from 68° to 72°F. Relative humidity is also important in comfort, with an acceptable range of 30–65%. At a relative humidity below 30%, people can suffer dry mucous membranes, which can lead to nosebleeds and infections. Low relative humidity is a typical problem found in winter months when the outside air is very dry. High relative humidity above 65% can lead to mold, mildew, and other biological growth. Mold growth is linked to allergic reactions, asthma attacks, and hypersensitivity pneumonitis (inflamed airways). Mold growth can be controlled by quickly eliminating any sources of water caused by leaks and maintaining relative humidity levels below 65%.

RESOURCES:

Environmental Health Perspectives, Environews by Topic page, <http://ehp.niehs.nih.gov/topic>. Choose Built Environment, Chemical Exposures, Children's Health, Environmental Health Education, Indoor Air Quality, Innovative Technologies

American Lung Association, <http://www.lungusa.org>

Australian Government Bureau of Meteorology, <http://www.bom.gov.au/lam/humiditycalc.shtml>

National Center for Healthy Housing, <http://www.centerforhealthyhousing.org/>

National Clearinghouse for Educational Facilities, <http://www.edfacilities.org/rl/iaq.cfm>

National Education Association Health Information Network, Asthma and Schools, <http://www.asthmaandschools.org/>

Psychometric charts and other tables are available on the Internet (e.g., http://www.sp.uconn.edu/~mdarre/NE-127/NewFiles/psychometric_inset.html)

U.S. Environmental Protection Agency

Indoor Air Quality Tools for Schools Program, <http://www.epa.gov/iaq/schools/index.html>

Indoor Air Quality Design Tools for Schools, <http://www.epa.gov/iaq/schooldesign/>

Indoor Air Quality Tools for Schools, Managing Asthma in the School Environment, <http://www.epa.gov/iaq/schools/asthma/index.html>

▶ Implementing the Lesson**INSTRUCTIONS:**

1. Have students read the article "Beyond the Bench: Mapping the Air in Public Schools."
2. Discuss with students the factors identified in the article that were important in the comfort and health of building occupants and why the variables measured were mapped using a geographic information system (GIS).
3. Tell students that they are going to carry out a similar investigation in their school to identify any air quality factors that may be affecting the school occupants' health and comfort. Review any vocabulary or other terms as needed. You may want to mention other potential indoor air quality issues and clarify that they will primarily be investigating temperature and relative humidity with some visual assessments of dust and mold. You may also want to discuss the potential influence of the current outdoor weather conditions on indoor air quality generally and the students' results specifically.



4. Depending on the size of your school, the number of rooms you will investigate, the number of available measurement instruments, and the number of students, divide your students into groups. Then pass out the materials and Student Instructions, and explain to students how they will determine the relative humidity. Choose one group to map the school floor plan. Depending on the level of detail required of the maps, you may choose to also have the mapping team collect temperature and humidity data. A more detailed map may include taking measurements and generating a to-scale map, accurately depicting the location of windows, doors, vents, air intakes, and filters.
5. Once all the groups have completed the activity, have each group present its findings and conclusions to the class. Have all of the groups' results summarized on the school floor plan developed by one of the groups. Transfer the floor plan with the measured results to an overhead transparency and project to the class during the discussion.
6. After all the groups have presented, discuss and summarize the groups' results.

NOTES & HELPFUL HINTS:

1. The most common way to measure relative humidity is to use a sling psychrometer (that measures wet bulb and dry bulb temperatures). Wet bulb and dry bulb temperatures can then be converted to relative humidity using a psychrometric chart or table. Be sure to follow the manufacturer's recommendations for operating and interpreting the results.
2. Psychrometric charts and other tables are also available on the Internet (see for example http://www.sp.uconn.edu/~mdarre/NE-127/NewFiles/psychrometric_inset.html). The Australian Government Bureau of Meteorology has a website at <http://www.bom.gov.au/lam/humiditycalc.shtml> that will calculate the relative humidity for you given a dry bulb and wet bulb temperature. The site also provides instructions for constructing your own psychrometer.
3. There are numerous types of sling psychrometers and direct reading instruments available for purchase. As appropriate, you may want to expand this lesson into the chemistry of relative humidity and how a sling psychrometer works.
4. Since students will be collecting temperature and humidity data over a period of several days/times and averaging their data, more advanced students could calculate the standard deviation. They could then make statements about whether there are any significant differences between the temperature or humidity in the rooms, which strengthens any conclusions resulting from the investigation.
5. If you partner with other teachers, students could collect data in those classrooms.

SKILLS USED OR DEVELOPED:

- communication (note taking, oral, written—including summarization)
- comprehension (listening, reading)
- computation
- critical thinking and response
- experimentation (conducting and data analysis)
- graph reading (if using a psychrometric chart)
- manipulation
- observation
- reading maps
- reading tables (if using a psychrometric table)
- research

SPECIFIC CONTENT ADDRESSED:

- conducting experiments
- making observations
- making measurements of temperature and relative humidity
- recording data
- making conclusions
- evaluating indoor air quality

NATIONAL SCIENCE EDUCATION STANDARDS MET:**Science Content Standards**

Unifying Concepts and Processes Standard

- Systems, order, and organization
- Evidence, models, and explanation



- Change, constancy, and measurement
- Evolution and equilibrium

Science As inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Physical Science Standards

- Structure of atoms
- Structure and properties of matter

Science in Personal and Social Perspectives Standards

- Personal and community health
- Natural resources
- Environmental quality
- Natural and human-induced hazards

▶ Assessing the Lesson

Use the temperature and relative humidity measurements from the article “Beyond the Bench: Mapping the Air in Public Schools” as a guide to what results might be achieved. It is impossible to predict what the results might be for your particular school. Evaluate the students on their ability to make the measurements, observations, and calculations accurately and to defend their conclusions based on the results.

▶ Authors and Reviewers

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STUDENT INSTRUCTIONS: Mapping the Air in Your School

Materials:

Per Group

- Graph paper and overhead transparency for the group making the school floor plan
- Thermometer
- Sling psychrometer or other device to measure relative humidity
- Psychrometric chart or table if supplied by your teacher to determine the relative humidity
- Watch

Procedure:

Step 1: You will be divided into groups by your teacher. One group will draw a floor plan for your school showing the rooms in your school and the results of all of the other groups' measurements. Other groups will be assigned rooms in the school and approximate times to measure temperature, and relative humidity, and conduct a room inspection.

Step 2: Complete your group assignments. If measuring temperature/relative humidity and inspecting classrooms, use the attached table to record your results. Then answer the questions that follow.

Survey Results Form

Room:							
Group:							
Date	Weather Conditions	Time	Temperature	Dry Bulb Temperature	Wet Bulb Temperature	Difference between Dry Bulb and Wet Bulb Temperature	Relative Humidity
		Average					



Description of Room:

1. Are supply and exhaust vents blocked or obstructed (e.g., by a desk or chalkboard)? Are supply and exhaust fans functioning properly? You can use paper to check intake and blowing.
2. What odors do you detect in the room? Describe them.
3. Are there any signs of mold or mildew growth (e.g., black or orange discoloration of ceiling or wall surfaces)?
4. Are there any signs of unresolved or ongoing water damage (e.g., water stains, loose floor tiles)?
5. Is the area generally clean and dust under control? Inspect vents if possible.
6. Do the room occupants report any concerns or problems (e.g., too hot, too cold, breezy, stuffy, stinky, other)?

Step 3: Provide your average temperature and relative humidity to the group that prepared a floor plan of your school.

Step 4: Read the article “Beyond the Bench: Mapping the Air in Public Schools” and compare your results with the results reported. Based on your results, do you believe your school has an indoor air quality problem? Explain.

Step 5: What else would you need to do for a more thorough investigation?

