SAFE ROUTES TO SCHOOLS

Satisfies Massachusetts Curriculum Frameworks standards

K–5 lessons in Health, Math, Social Studies & Science/Technology

Teaches children to connect walking, health and the environment

15 hands-on print & Internet lesson plans

Walking for Health & the Environment Curriculum

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Safe Routes to Schools

Walking for Health & the Environment Curriculum

for Massachusetts Elementary School Teachers

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DISCLAIMER

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Acknowledgments

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WalkBoston is a nonprofit advocacy organization whose mission is to raise public awareness about the benefits of walking for transportation, health, recreation, and vital communities. Since 2000, when WalkBoston introduced the first comprehensive Safe Routes to Schools (SRS) program in New England, the organization has offered SRS programs in the metro Boston area. WalkBoston advocates for statewide Massachusetts Safe Routes to Schools programs.

Eastern Research Group is a national consulting firm that specializes in environmental communications and services. ERG creates enriching educational programs for schoolchildren and adults and develops publications, presentations, websites, and scientific and economic analyses on a wide range of environmental and public health topics.

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Table of Contents


= Internet activity

Teachers' Guide

Today, most children in the United States arrive at school by school bus or in their parents' cars. But it wasn't always this way, and children are not necessarily benefiting from these "easy" rides:

- The number of children walking or bicycling to school has dwindled in the last 30 years – walking has plummeted from 66 to 13 percent, and cycling has dropped 63 percent (Centers for Disease Control, 2000).
- Various sources estimate that as much as 20 to 30 percent of morning peak traffic volumes are caused by parents dropping their children off at school.
- A major form of physical activity for children has all but disappeared. The percentage of children 6 to 11 who are overweight has more than tripled in the last 30 years, and doubled for adolescents and preschoolers (Institute of Medicine, 2004).

One way to reverse these trends is through Safe Routes to Schools (SRS) programs. Walking and bicycling to school can help address the growing public health concern of obesity and result in better overall health. Walking and bicycling to school also help reduce traffic congestion, fuel consumption, and air pollution, with resulting public health benefits, as well as enhance vital community life. Finally, when students regularly walk or bicycle to school, they learn about their communities, develop increased responsibility and independence, and arrive at school more alert and ready to learn.

PURPOSE OF THIS CURRICULUM

This curriculum was created for Massachusetts teachers who want to help children learn about the connections between walking, health, and environmental quality, whether or not their school is operating a walk-to-school program. The curriculum consists of fifteen hands-on, easy-to-implement lesson plans for Grades K-5. **Each lesson meets Massachusetts Curriculum Frameworks standards.** The lessons typically meet several Curriculum Frameworks standards concurrently, such as Science, Math, Social Science, and Comprehensive Health.

The lessons encourage students to think about ways in which they, their families, and their communities can help reduce traffic and associated air pollution through walking, bicycling, and using public transportation. The lessons help students see that walking is a fun and easy form of daily exercise that is good for their overall health.

The curriculum includes both classroom and out-of-class field activities, such as mapping routes from students' homes to their schools, creating a simple air pollution tester, and measuring breathing and heart rates before and after physical activity. Many of the lessons are ideal for collaborative efforts among classroom teachers, physical education teachers, and computer lab instructors. The curriculum includes ten lessons for Grades 3-5 and five lessons for Grades K-2. These lessons have been reviewed by Massachusetts teachers and tested in classrooms – with outstanding results! (See *Teacher Comments* on page 6.)

The table on pages 3-5 lists the lesson plans and the Massachusetts Curriculum Frameworks that each lesson meets. Many of the lessons address several different curriculum areas. Specific Curriculum Frameworks learning standards met are listed at the end of each lesson.

USING THIS CURRICULUM

Each lesson plan in this curriculum contains the following lesson activity sections:

- Grade Level
- Learning Objectives
- Estimated Time
- Summary
- Key Questions
- Background
- Materials
- Steps
- Adaptation
- For Further Explanation
- Resources/Acknowledgments
- Massachusetts Curriculum Frameworks Standards

Background sections. The *Background* sections in each lesson provide teachers with key background information needed for conducting the lessons. These sections are written at a level that assists teachers in communicating relatively complex environmental and health concepts to students in easy-to-understand language.

Internet activities. Some of the lessons involve Internet access; these are identified as internet activities in the *Table of Contents* and in the *Materials* section of the lesson plans. We included Internet activities because many good lesson plans are now available on the Web, and because we anticipate that many schools and classrooms (or computer labs) now have Internet access. In some cases, we included printed copies of key materials found on the Web when this might be helpful.

It may appear that some overlap exists within this curriculum, particularly regarding air pollution. However, each of the lessons has a different emphasis. For example, *Is the Air Quality Good Where I Live?* focuses on ozone formation and locations, while *Smog City* focuses on weather and human causes of smog/ozone. *Milkweed Polka Dots* describes ozone damage to plants. *Particle Pollution: How Dirty is the Air We Breathe?* focuses on particle pollution (rather than ozone), while *Now You See It, Now You Don't* highlights states of matter (gases, liquids, solids).

Recognizing that individual lessons may be photocopied and shared, each lesson plan also includes the following statement of purpose:

This Safe Routes to Schools Curriculum has two purposes: To teach elementary school students—in ways that are stimulating and relevant to their lives—how walking is good for their bodies and good for the environment, while also helping teachers satisfy the requirements of the Massachusetts Curriculum Frameworks.

This curriculum teaches children about the benefits of walking to school and about how our health and environment are connected to our transportation choices. Understanding these issues will help children make informed, positive choices that are good for them, their communities, and our planet. We hope you and your students find this curriculum useful and fun.

We welcome feedback from you at any time for our future efforts. Please write: Safe Routes to Schools Program Manager, WalkBoston, Old City Hall, 45 School Street, Boston, MA 02108.

Lessons and Their Alignment with Massachusetts Curriculum Frameworks*

Massachusetts Curriculum Frameworks			
	Comprehensive Health	**Science and Technology/ Engineering**	**Mathematics**
Lessons:			
Grades K-2:			
Now You See It, Now You Don't	• Personal and Community Health	• Earth and Space Science – Earth's Materials; Weather • Life Science – Characteristics of Living Things; Living Things and Their Environment • Physical Sciences – States of Matter • Appendix V: Historical and Social Context	
Particle Pollution: How Dirty Is the Air We Breathe?	• Personal and Community Health	• Earth and Space Science – Earth's Materials; Weather • Life Science – Characteristics of Living Things; Living Things and Their Environment • Physical Sciences – States of Matter • Technology/Engineering • Appendix V: Historical and Social Context	
Milkweed Polka Dots	• Personal and Community Health	• Life Science – Characteristics of Living Things; Living Things and Their Environment • Physical Sciences – States of Matter • Appendix V: Historical and Social Context	
What Color Is My Air Today?	• Personal and Community Health	• Life Science – Characteristics of Living Things; Living Things and Their Environment • Appendix V: Historical and Social Context	• Number Sense and Operations • Patterns, Relations, and Algebra • Data Analysis, Statistics, and Probability
Smog City (K–2)	• Personal and Community Health	• Earth and Space Science – Earth's Materials; Weather • Life Science – Characteristics of Living Things; Living Things and Their Environment • Appendix V: Historical and Social Context	

Note: Individual lessons list specific learning standards met.

Lessons and Their Alignment with Massachusetts Curriculum Frameworks* (Cont.)

Massachusetts Curriculum Frameworks			
	Comprehensive Health	**Science and Technology/ Engineering**	**Mathematics**
Lessons:			
Grades 3-5:			
Breathing and Exercise	• Physical Health • Personal and Community Health		
Heart Rate and Exercise	• Physical Health • Personal and Community Health		
Is the Air Good Where I Live?	• Personal and Community Health	• Earth and Space Science – Weather • Life Science – Adaptations of Living Things • Technology/ Engineering • Appendix V: Historical and Social Context	• Patterns, Relations, and Algebra
Smog City (3–5)	• Personal and Community Health	• Earth and Space Science – Weather • Life Science – Adaptations of Living Things	
Too Many Blankets – #1	• Personal and Community Health	• Earth and Space Science – Weather • Life Science – Adaptations of Living Things • Technology/ Engineering	• Measurement
Too Many Blankets – #2	• Personal and Community Health	• Earth and Space Science – Weather • Life Science – Adaptations of Living Things • Physical Sciences – Light Energy • Technology/ Engineering • Appendix V: Historical and Social Context	
How Far Do You Walk at School?			• Number Sense and Operation • Measurement

Lessons and Their Alignment with Massachusetts Curriculum Frameworks* (Cont.)

Massachusetts Curriculum Frameworks				
	Comprehensive Health	**Science and Technology/ Engineering**	**Mathematics**	**History and Social Science**
Lessons:				
Grades 3-5:				
How Much Pollution Is That Car Producin'?	• Personal and Community Health	• Appendix V: Historical and Social Context	• Number Sense and Operation	• MA and Its Cities and Towns
Traffic Tally	• Personal and Community Health	• Technology/ Engineering • Appendix V: Historical and Social Context	• Number Sense and Operations • Patterns, Relations, and Algebra • Measurement • Data Analysis, Statistics, and Probability	
Walk Across Massachusetts	• Personal and Community Health	• Life Science – Adaptations of Living Things • Appendix V: Historical and Social Context	• Number Sense and Operations • Patterns, Relations, and Algebra	• MA and Its Cities and Towns

Note: Individual lessons list specific learning standards met.

TEACHER COMMENTS

The comments below reflect some of the experiences of teachers who have reviewed or used the lessons in this curriculum.

What Color is My Air Today?

"The lesson fits perfectly into the curriculum requirements…The lesson is teacher- and student-friendly. Learning about air quality and the Air Quality Index was a big hit with the students. They want to check the paper daily to see what the index says about the quality of the air."

How Dirty Is the Air We Breathe?

"This lesson fits into standard curriculum requirements. The lesson is written in an easy way for teachers to understand…it was straightforward and organized…Due to high interest and enthusiasm on the part of my students, I would like to do it with all my future classes."

How Far Do You Walk At School?

"The students enjoyed walking each Friday and revealing how far they walked using the pedometers…I would certainly continue this project in the future."

Lesson Plans

Grades K-2

Now You See It, Now You Don't

GRADES K-2

LEARNING OBJECTIVES

Students will:

- Observe differences between gases/solutions and particles, in the context of air pollution.
- Classify common atmospheric gaseous and particle pollutants in the air.

ESTIMATED TIME

30 minutes

SUMMARY

In this lesson, students will observe the differences between gaseous air pollution, represented by a solution of milk in water, and particle air pollution, represented by suspended particles of pepper in water. Students will then classify common atmospheric gases and particles that can contribute to air pollution.

KEY QUESTION

- What is the water supposed to represent? (*Answer:* Air, or air in the atmosphere)

BACKGROUND

There are different kinds of air pollution: some are particles, such as dirt or other small pieces of solid materials, and others are gases, such as ozone, which is made up of three oxygen atoms. The cars that we drive can send both particle pollution and gaseous pollution into the air. If more people walked to more places instead of driving to them, fewer cars would be on the road, and this would reduce air pollution.

MATERIALS

- Two clear glass bowls (if teacher demonstrates) or large clear plastic cups (if students perform activity)*
- One tablespoon of milk for each bowl or cup
- One teaspoon of pepper for each bowl or cup
- One plastic spoon for each bowl or cup
- Water
- Student Worksheet (included)
- Teacher Answer sheet (included)

****Note to Teachers:*** If the teacher does this as a demonstration with the clear glass bowl, it helps to have a light or white paper behind the pepper so it is easier to observe. Alternatively, students can do this in small groups using clear disposable cups instead of the glass bowl.

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STEPS

1. **Review vocabulary, pour water, and explain that the water represents the air.**

   Review as needed relevant vocabulary, such as gases, particles, pollution, mixture, and atmosphere. Divide the class into small groups (if teacher not conducting activity for the entire class). Fill clear glass bowl or clear disposable cups half full with water. Remind the students that the water represents air in the atmosphere. Tell students to carefully observe what happens as you add things to the water.

2. **Add milk to the clear container of water; ask what kind of air pollutant the milk acted like.**

   First add one tablespoon of milk to the water and stir to mix. Then ask: What happened to the milk when it was added to the water? (*Answer:* It mixed with the water, or a similar answer.) Then ask: What kind of pollutant(s) did the milk act like in the water? (*Answer:* A gas, or gaseous air pollution.)

3. **Add pepper to another bowl or cup of water; ask the class what kind of air pollutant the pepper acted like.**

   First, add one teaspoon of pepper to the water and stir. Then ask: What happened to the pepper when it was added to the water? (*Answer:* It did not mix with the water, or a similar answer.) Then ask: What kind of pollutant(s) did the pepper act like in the water? (*Answer:* Particles, or particle pollution.)

4. ***Ask:* Would it be easier to get the milk or the pepper out of the water?**

   If the containers were left on a shelf all day, which would "settle" out of the water, the pepper or milk? (*Answer:* Pepper)

5. ***Ask:* Would it be easier to remove gases or particles out of the air?**

   (Answer: Particles)

6. ***Review:* What does the pepper represent? What does the milk represent?**

   Review: What does the pepper represent? (*Answer:* Particle air pollution). What does the milk represent? (*Answer:* Gaseous air pollution).

7. **Use Student Worksheet.**

   Use the Student Worksheet, first for word recognition, then have students fill out the Worksheet as follows:

(a) Begin this step as a word recognition task: For older students who can read (e.g., Grade 2), tell students to highlight or circle some of the (easier) words they recognize (with some assistance) on the Student Worksheet; suggested words include: ash, car exhaust, cigarette smoke, cow burps, dirt, dust, forest fires, lead, lightning, ozone, pollen, rotting leaves, soot, street sanding, swamp gases. For younger students, you can count down the list with them to words they understand the meaning of and read them aloud.

(b) Next, tell students to fill out the Worksheet for the highlighted or circled items. Tell them to check off whether they think the pollutant listed in the left-hand column is a particle, a gas, or both. (*Note:* The Teacher Answer Sheet provides the correct answers.)

ADAPTATION

Students could receive a star or sticker for answering correctly, or for filling out additional items.

For older students (Grades 3-5), have them fill out the entire Worksheet. Also, introduce the concepts of solutions (i.e., milk and water) and suspensions (i.e., pepper and water) in scientific terms. Also, see the lesson plan, "Parts Per Million," on the Rutgers University website listed below.

FOR FURTHER EXPLORATION

Have the students research some of the types of air pollution listed on the Student Worksheet.

RESOURCES, ACKNOWLEDGMENTS

Suspended Particulates Lab Lesson Plan. Rutgers Engineering. URL: www.engineeringplanet.rutgers.edu

MA CURRICULUM FRAMEWORKS STANDARDS

Grades K-2

Science and Technology/Engineering Curriculum

Earth and Space Science – Earth's Materials

- Understand that air is a mixture of gases that is all around us…*(Learning Standard 2)*

Life Science (Biology) – Living Things and Their Environment

- Recognize that people and other animals interact with the environment…*(Learning Standard 6)*

Physical Sciences (Chemistry and Physics) – States of Matter

- Identify objects and materials as solid, liquid, or gas. *(Learning Standard)*

Appendix V: Historical and Social Context for Science and Technology/Engineering

- How government, industry, and/or individuals may be responsible for negative effects; damage to the environment or ecosystems…; some sources of damage or pollution *(IV. Unintended negative effects…)*

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community health *(Learning Standard 14.2)*

Student Worksheet:
Now You See It, Now You Don't

Student Name: _____

Type of Pollutant	Particles	Gases	Both
Agricultural burning			
Ash			
Car exhaust			
Carbon dioxide (CO_2)			
Carbon monoxide (CO)			
Cigarette smoke			
Cow burps			
Dirt			
Dust			
Fireplace smoke			
Forest fires			
Haze			
Industrial emissions			
Lead			
Lightning			
Nitrogen oxides (NO_x)			
Ozone			
Pollen			
Power plants			
Rice field gases			
Rotting leaves			
Sewer gases			
Soot			
Street sanding			
Sulfer dioxide (SO_2)			
Swamp gases			
Volcanic ash			

Teacher Answer Sheet:
Now You See It, Now You Don't

Student Name: _____

Type of Pollutant	Particles	Gases	Both
Agricultural burning			✔
Ash	✔		
Car exhaust			✔
Carbon dioxide (CO_2)		✔	
Carbon monoxide (CO)		✔	
Cigarette smoke			✔
Cow burps		✔	
Dirt	✔		
Dust	✔		
Fireplace smoke			✔
Forest fires			✔
Haze			✔
Industrial emissions			✔
Lead	✔		
Lightning		✔	
Nitrogen oxides (NO_x)		✔	
Ozone		✔	
Pollen	✔		
Power plants			✔
Rice field gases		✔	
Rotting leaves		✔	
Sewer gases		✔	
Soot	✔		
Street sanding	✔		
Sulfer dioxide (SO_2)		✔	
Swamp gases		✔	
Volcanic ash	✔		

Particle Pollution: How Dirty Is the Air We Breathe?

GRADES K-2

LEARNING OBJECTIVES

Students will:

- Make a simple particle pollution tester.
- Collect and observe particle pollution from the air and record findings.

ESTIMATED TIME

30 minutes (indoors)
30 minutes (outdoors)

SUMMARY

In this activity, students will collect samples of particle pollution outdoors on plastic squares coated with petroleum jelly, and discuss the causes and impacts of particle air pollution.

KEY QUESTIONS

- In what types of places might the most air pollution occur? *(Possible answers:* Near busy roads with lots of traffic; near factories or power plants)
- Do you think that people's health can be affected by breathing in air pollution? How? *(Answers:* Difficulty breathing, asthma, other breathing/lung problems, heart disease)
- How might we help keep the air clean? *(Possible answers:* By walking places instead of driving to them, with an adult, when it's safe to do so.)

BACKGROUND

The Earth's atmosphere is made up mostly of invisible gases. Most air pollution also is invisible. Some air pollutants are gases, while others are liquids or solid particles. Sometimes you can see air pollution, when large amounts of certain kinds of pollution are in one place (such as a city). One type of air pollutant is called particle pollution. Particle pollution is made up of tiny solid particles, like specks of dirt, and droplets of liquid. A lot of particle pollution comes from things that people do, like driving cars and trucks that burn gasoline and put pollutants into the air from the vehicles' tailpipes. The smokestacks of factories also put pollutants into the air; these pollutants are caused by the burning of oil and coal in the factories to run the machines used to make things. Some things in nature also create particle pollution, such as forest fires and volcanic ash. Wind can blow air pollution from where it was created to other places far away. Sometimes air pollution makes it hard to see distant objects, like mountains or the city skyline.

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MATERIALS

- Plastic squares (5 cm by 5 cm or 2 inch by 2 inch)
- Petroleum jelly
- Masking tape
- Blocks of wood
- White paper for each child or each group of children
- Adult assistants for outdoor placement of wood blocks

STEPS

1. Tell students they will make a particle air pollution tester.

Introduce the class to different kinds of pollution – gaseous and particles – as described in the *Background.* Tell students: As we look outside, we often see a clear blue sky. Where is air pollution? We are going to make a simple tester for particle air pollution so we can see it.

2. Have students make the testers.

Divide the class into groups and give them their materials. With masking tape, have each group fasten their plastic square to the wooden block. Then have them apply a thin, even coat of petroleum jelly to the plastic square.

3. Place the blocks outside.

With the class and adult assistants, place the blocks outdoors on posts, fences, walls, and/or window sills in various locations. If you can, place some blocks near a road and some in a protected location away from roads. Try to pick places where the blocks won't be knocked over by pets or children's play. Leave the blocks for 24 hours.

4. Collect the testers.

The next day, collect the wooden blocks and keep a record of where each block was placed. Remove the plastic squares from the blocks and lay the squares on white paper.

5. Examine the pollution collected on the testers.

Let the students examine the pollution that collected on the petroleum jelly.

6. Discuss the findings.

Have the groups discuss (and record, if age-appropriate) the findings of their testers.

Have groups share their findings with the class. *Ask:* Did your tester collect any particles? How does your square compare to those of the other groups? In what places does the air seem to be the dirtiest? *(Possible answers:* Near busy roads, near factories.) Why do you think those areas might have the most particle pollution? *(Possible answers:* Because cars and factories make pollution.)

7. Discuss possible health effects of breathing air pollution.

Say: We have seen particle pollution where we first didn't see any. Clean air is important for us to breathe to be healthy. Breathing in particle pollution (dirty air) can make us sick – it can cause people to have difficulty breathing, asthma, other breathing/lung problems, or heart disease.

8. Discuss what people can do to reduce air pollution.

Ask: What can we do to keep the air clean? *(Possible answers:* People could drive less and walk more, such as to school. We can turn off lights, TVs, and computers when we're not using them. Factories could reduce their pollution.)

ADAPTATION

For Grades 3-5, have students write a paper explaining the differences they observed among the plastic squares. Ask students to leave the tester outside for a week, a month (sheltered from precipitation); students can keep a journal of its progress each day and report to the class. Have students compile data on their findings and write the mayor or a municipal board about their samples.

For Grades K-2, to simplify testing, place pieces of double-sided masking tape (instead of petroleum jelly on wood blocks) on trees in various locations and compare the results.

FOR FURTHER EXPLORATION

Have students take their tester home (along with instructions for parental assistance) to test for pollution for 24 hours. Students will then report their findings to the class the next day.

RESOURCES, ACKNOWLEDGMENTS

Holt Science 6th. Holt, Rinehart, and Winston Publishers, New York. p. 257.

Texas Natural Resource Conservation Commission (TNRCC). URL: http://www.tnrcc.state.tx.us/air/monops/lessons/partlesson4.html

MA CURRICULUM FRAMEWORKS STANDARDS

Grades K-2

Science and Technology/Engineering Curriculum

Earth and Space Science – Earth's Materials

- Understand that air is a mixture of gases that is all around us and that wind is moving air *(Learning Standard 2)*

Life Science (Biology) – Living Things and Their Environment

- Recognize that people and other animals interact with the environment…*(Learning Standard 6)*

Physical Sciences (Chemistry and Physics) – States of Matter

- Identify objects and materials as solid, liquid, or gas. *(Learning Standard)*

Technology/Engineering

- Identify and describe the safe and proper use of tools and materials…to construct simple structures (Learning Standard 1.3)

Appendix V: Historical and Social Context for Science and Technology/Engineering

- How government, industry, and/or individuals may be responsible for negative effects…; damage to the environment or ecosystems… ; some sources of damage or pollution *(IV. Unintended negative effect…)*

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community health *(Learning Standard 14.2)*

Grades 3-5 (for "Adaptation" section)

Science and Technology/Engineering

Life Science (Biology) – Adaptations of Living Things

- Give examples of how organisms can cause changes in their environment…explain how these changes may affect the ecosystem *(Learning Standard 10)*

Physical Sciences (Chemistry and Physics) – States of Matter

- Compare and contrast solids, liquids, and gases based on the basic properties of each of these states of matter *(Learning Standard 2)*

Technology/Engineering

- Identify materials used to accomplish a design task based on a specific property…*(Learning Standard 1.3)*

Milkweed Polka Dots

GRADES K-2

LEARNING OBJECTIVES

Students will:

- Understand that air pollution can damage plants.
- Use observational skills to identify damage to plants caused by ozone rather by than other causes.

ESTIMATED TIME

40 minutes

SUMMARY

In this Internet activity, students will learn that plants can be damaged by air pollution. Students will examine photos of milkweed leaves, which typically display black dots on their top leaf surfaces when stressed by large amounts of ground-level ozone. Students will compare ozone damage to other types of damage.

KEY QUESTIONS

- What things do you think might cause air pollution? *(Possible answers:* Cars that we drive, factories that make things we use.)
- What can people do to reduce air pollution? *(Possible answers:* Walk, bicycle, or take a train or bus instead of driving places. Buy cars that use less gasoline.)

BACKGROUND

When too much dirt or chemicals get into our air, the air is dirty, or polluted. Some types of air pollution can injure plants. One type of air pollution called ozone pollution can injure milkweed plants. Lots of other things can also cause damage to milkweed, like too much hot weather, not enough plant food, or caterpillars eating the leaves, so not all damage to milkweed is caused by air pollution. The damage that ozone causes to milkweed looks like small black dots on the top surfaces of the leaves. If the dots are brown, red, purple, or another color, or are on the bottom of the leaf, it's not ozone damage. Also, ozone doesn't damage the veins of the leaf; other things would cause that type of damage. Ozone damage won't rub off or wash off. Many leaves have more than one type of damage.

Note: You might want to explain briefly to students that ozone, which is the topic of this lesson, is created when chemicals from cars are mixed with certain other chemicals from factories and products like paint, and this mixture is heated by the sun. See full description of ozone in the *Is The Air Good Where I Live?* lesson.

MATERIALS

- Internet access
- If possible, milkweed plant leaves (preferably both healthy leaves and leaves with ozone damage, as described under the *Background* above)

STEPS

1. Introduce students to milkweed on the "Environmental Education for Kids" website.

You can introduce students to both milkweed and monarch butterflies on the following Internet website:
URL: http://www.dnr.state.wi.us/org/caer/ce/eek/veg/plants/milkweed.htm
Milkweeds are common wild plants in Massachusetts (as well as in Wisconsin, where this website was created). Monarchs need milkweed to survive. The butterfly lays its eggs on milkweed plants and the caterpillars eat the leaves.

After showing students a healthy millkweed, go to the following Internet web page which shows milkweed ozone damage:
URL: http://www.dnr.state.wi.us/org/caer/ce/eek/earth/field/milkweed/slideshowindex.htm
(Since the URLs for these websites are so long (!), you may want to first save them to your "Favorites" list for easy access.)

2. Have students view (and possibly draw) an ozone-damaged leaf; review the symptoms of ozone damage with them.

If time permits, you may want to have students draw and predict what a milkweed leaf that is damaged by ozone looks like (or, you can draw one for them), based on the description in the *Background* above. Have students study the photo of the ozone-damaged leaf. Review the symptoms of milkweed damage from ozone pollution (from the *Background*) with students: small black dots on the top (not bottom) of the leaves; damage to the leaf, not the veins; damage won't rub off or wash off.

3. View and discuss slides of damaged milkweed leaves with students.

On this same Internet page, click on "See the list of slides." Based on time availability, either have students pick a few of these slides to compare with the ozone-damaged leaf photo, or allow them to view the entire slide show. Share with students the information provided on each slide regarding how the damage shown differs from ozone damage to milkweed leaves.

4. Discuss milkweed damage shown on slides.

Discuss the different types of milkweed damage observed on some of the slides and their causes.

5. Ask students what they and other people can do to reduce air pollution.

Ask students what people can do to reduce air pollution, and what they themselves can do.

ADAPTATION

For older students, have them examine the Data Tables at the Internet URL: http://www.dnr.state.wi.us/org/caer/ce/eek/earth/field/milkweed/datatable.htm

Then have students make comparisons across the data, such as comparing results for the different schools listed for the years 2000 – 2004 for the categories "Highest Level of Ozone Injury Found" and "Average % of Ozone Injured Leaves Per Plant."

FOR FURTHER EXPLORATION

Conduct a milkweed monitoring field trip; see the following Internet website for procedures:
URL: www.easybreathers.org/pdf/engage/milkweed.pdf

RESOURCES, ACKNOWLEDGMENTS

EEK! Teachers Pages – Milkweed Monitoring Project
URL: www.dnr.state.wi.us/org/caer/ce/eek/teacher/milkweedmonitoring.htm

MA CURRICULUM FRAMEWORKS STANDARDS

Grades K-2

Science and Technology/Engineering Curriculum

Life Science (Biology)

- Characteristics of Living Things - Recognize that animals (including humans) and plants are living things that grow, reproduce, and need food, air, and water *(Learning Standard 1).*
- Living Things and Their Environment – Recognize that people and other animals interact with the environment through their senses of sight, hearing, touch, smell, and taste *(Learning Standard 6).*

Physical Sciences (Chemistry and Physics)

- Sort objects by observable properties such as size, shape, color, weight, and texture *(Learning Standard 1).*

Appendix V: Historical and Social Context for Science and Technology/Engineering

- How government, industry, and/or individuals may be responsible for negative effects…; damage to the environment or ecosystems…; some sources of damage or pollution *(IV. Unintended negative effects from uses of science and technology/engineering).*

MA CURRICULUM FRAMEWORKS STANDARDS (CONT.)

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1).*
- Identify ways the physical environment is related to individual and community *(Learning Standard 14.2).*

What Color Is My Air Today?

GRADES K-2

LEARNING OBJECTIVES

Students will:

- Understand how breathing the air can affect people's bodies and health.
- Describe how colors and numbers can represent different classifications of something, such as levels of air quality.
- Understand that air pollution, driving, and health are connected.

ESTIMATED TIME

30 minutes

SUMMARY

In this lesson, the class will discuss air quality and how walking, instead of driving cars, helps improve air quality. Using the EPA's online Air Quality Index color game, students will learn that air quality can be classified according to different levels of pollution and that these levels can be represented by colors and/or numbers. They will also learn that they can find out what the air quality index is on any given day and understand what it means for people's outdoor activities.

KEY QUESTIONS

- What is air pollution?
- What is the Air Quality Index?
- How can you and your family help reduce air pollution?

BACKGROUND

When you walk to school or other places, on a clear, breezy day, the air smells fresh and clean. Clean air is air that has no harmful levels of pollutants (such as dirt and chemicals) in it. Clean air is good for people to breathe. However, on a hot day with no wind—especially in some cities—the air can feel heavy and may have a bad smell. Sometimes, the air can even make your chest feel tight, or make you cough. When too much dirt or chemicals get into the air, the air is dirty, or polluted (see photos on pages 30-31). Polluted air is not good for people to breathe. Gasoline-burning cars contribute to air pollution. To reduce air pollution, students and their families can walk more, ride their bikes, or carpool. (Carpooling is when people who are not related to each other share a ride somewhere.) People can also take the bus, train, or subway to reduce air pollution instead of driving in their cars.

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The government measures pollution in the air across the country. Then they use something called the Air Quality Index, or AQI for short, to tell people how clean or dirty the air is each day in different places. The AQI uses colors, words, and numbers to tell you about the air.

MATERIALS

- Internet access (black and white copies of the *AQI Color Game* and *Answer Sheet* are included at the end of this lesson for reference, but using the online color version is preferred)
- Computer printer (preferably color, if not conducting activity online)
- Pencils

STEPS

1. Access the Air Quality Index Color Game online or distribute printed copies.

Have the class play the AQI Color Game online, or print out and hand out copies of the game (easy version) from the EPA AIRNow website URL: http://airnow.gov/index.cfm?action=aqikids.games
(This lesson is based on the game version that "can be printed out and completed" found towards the bottom of the Internet page. You can also [or instead] play the animated online version.)

Note to Teachers: It may take a minute for the color chart to load onto your computer. Also, the AQI Game is available online at different levels: easy, medium, and hard. First have students play the "easy" game, which discusses AQI colors only. Then add a discussion of the AQI numbers, as discussed in the Steps below. The medium and hard versions of the game are appropriate for students in Grades 3-5.

If printing, also print out the answer key for the teacher. It is best if the student game can be printed in color.

2. Discuss the AQI colors and their meaning with students.

Tell students that each day, the AQI is one of these colors. The colors tell you how healthy the air is to breathe that day. The colors go from Green to Yellow to Orange to Red to Purple, with each color telling you that the air is less clean than the color before. (Note: If students ask, you can tell them that the last AQI color, Maroon, which represents the worst air quality, is usually not included with the other AQI colors because air quality in the U.S has not been Maroon in many years. This is probably because people have been working hard to clean up the air.)

If Color is…	This Means…
Green	The air is good and healthy to breathe.
Yellow	The air is "moderate" - it's fine for most people, including children like you. However, if you know you are extra sensitive to pollution, you might want to limit the time you spend playing outside when the AQI is yellow.
Orange	The air is unhealthy for sensitive groups. People with lung problems, such as asthma, and active kids and grown-ups should limit how long or how hard they play actively outside. If you don't feel so great, take it a little easier when the AQI is orange.
Red	The air is unhealthy. People with lung problems, such as asthma, and active kids and grown-ups should not spend a long time playing actively outdoors. Everybody else should limit how long they are active outside.
Purple	The air is very unhealthy. People with lung problems, such as asthma, and active kids and grown-ups should not spend any time playing or being active outdoors. Everyone else should limit outdoor activities.

3. Tell students to look at their AQI Color Game sheet.

Tell them to draw a line from the AQI words on the left side to the correct color on the right side. For younger students (e.g., kindergarten), the teacher can read the words and ask students which words go with which colors. For older students (e.g, Grade 2), the teacher may need to assist students in reading and understanding some of the key words, as discussed in the table above.

4. Discuss the correct answers using the teacher answer sheet.

5. Add a discussion of the AQI numbering system.

An index uses numbers to tell people how good or bad something is. For example, you might say your school lunch is a 1 (very good) or a 5 (yucky). The Air Quality Index uses numbers from 0 to 500. These numbers are used to decide the AQI color for a particular day. On days measuring less than 100, the air is clean. If the air is dirtier, the numbers get bigger. On days measuring more than 100, the air can be bad for you to breathe.

Here is how the AQI numbers match up with the AQI colors:

AQI Numbers	AQI Colors
0 to 50	Green
51 to 100	Yellow
101 to 150	Orange
151 to 200	Red
201 to 300	Purple

6. Have students view the AQI posters.

Next, have students view the six AQI color posters online, or print out several sets of the posters and pass them around the class, available from the EPA AIRNow website at:
URL: http://www.epa.gov/airnow//aqikids/pdffiles/posters.pdf
It is best if these posters can be printed out in color.

7. Discuss the six posters in sequence.

Discuss the six posters in sequence (from Green to Purple), which will reinforce the lesson thus far, including both AQI colors and numbers.

8. Remind students how they can help reduce air pollution.

Remind students that to reduce air pollution, they and their families and friends can walk more, ride their bikes, carpool, and take the bus, train, or subway instead of driving in their cars.

ADAPTATION

For older students (Grades 3-5), play the Medium and/or Hard versions of the AQI Color Game. Add more in-depth discussion from the EPA website at:
URL:http://www.epa.gov/airnow//aqikids/pdffiles/aqirefer.pdf

FOR FURTHER EXPLORATION

If using the Internet, go to http://www.airnow.gov and click on "Today's Forecast" then click on a city located nearby. Ask students what the air quality is for today and expected to be tomorrow.

Have students try to find and cut out the Air Quality Index in the newspaper and bring it in to class to discuss; the AQI can often be found on the weather page in newspapers.

RESOURCES, ACKNOWLEDGMENTS

U.S. EPA. Air Quality Index Kids Page.
URL: http://airnow.gov/index.cfm?action=aqikids.index

MA CURRICULUM FRAMEWORKS STANDARDS

Grades K-2

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1).*
- Identify ways the physical environment is related to individual and community health *(Learning Standard 14.2).*

Science and Technology/Engineering Curriculum

Life Science (Biology) – Living Things and Their Environment

- Recognize that people and other animals interact with the environment through their senses of sight, hearing, touch, smell, and taste *(Learning Standard 6).*

Appendix V: Historical and Social Context for Science and Technology/Engineering

- How government, industry, and/or individuals may be responsible for negative effects…; damage to the environment or ecosystems…; some sources of damage or pollution *(IV. Unintended negative effects from uses of science and technology/engineering).*

Mathematics Curriculum

Number Sense and Operations

- Identify positions of objects in sequences *(e.g., first, second) up to fifth (Learning Standard K.N.3)*
- Name and write (in numerals) whole numbers to 1000, identify the place values of the digits, and order the numbers *(Learning Standard 2.N.1).*

Patterns, Relations, and Algebra

- Identify the attributes of objects as a foundation for sorting and classifying *(Learning Standard K.P.1).*
- Sort and classify objects by color, shape, size, number, and other properties *(Learning Standard K.P.2).*
- Identify, reproduce, describe, extend, and create simple rhythmic, shape, size, number, color, and letter repeating patterns *(Learning Standard 2.P.1).*

Data Analysis, Statistics, and Probability

- Collect, sort, organize, and draw conclusions about data using concrete objects, pictures, numbers, and graphs *(Learning Standard K.D.1).*
- Organize, classify, represent, and interpret data using tallies, charts, tables, bar graphs, pictographs, and Venn diagrams; interpret the representations *(Learning Standard 2.D.2).*

AQI Color Game

Easy Game

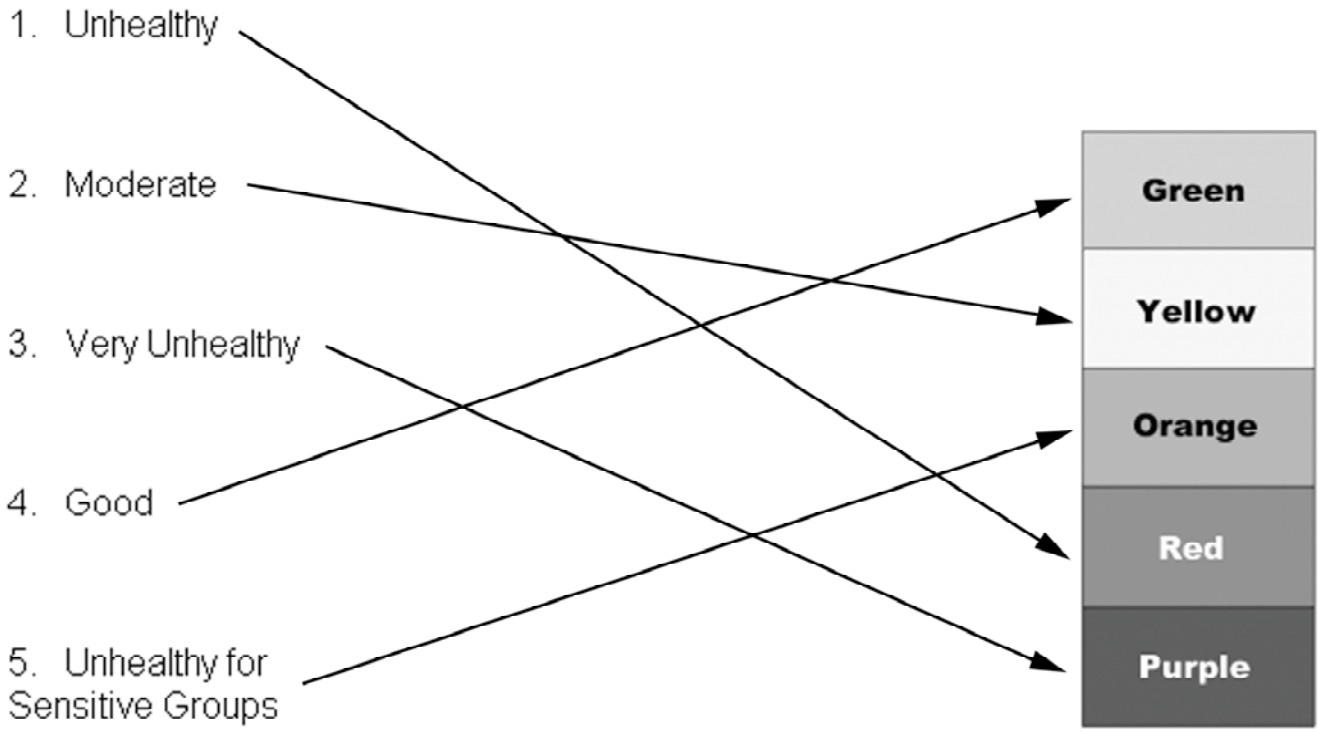
To play this game, first print this page and then draw a line from the AQI word(s) on the left side to the correct color on the right.

1. Unhealthy
2. Moderate
3. Very Unhealthy
4. Good
5. Unhealthy for Sensitive Groups

Click here to view the completed game.

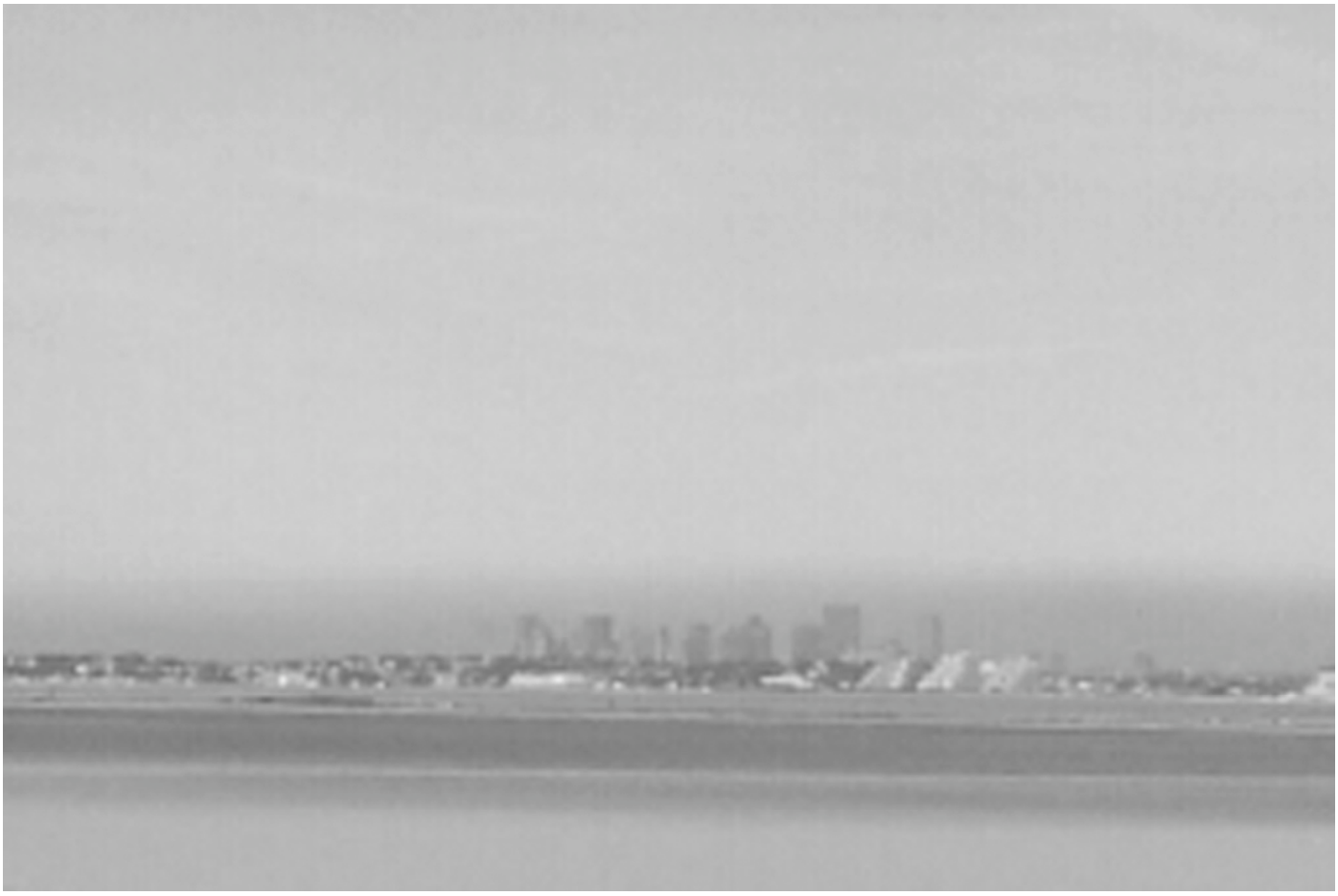
AQI Color Game

Easy Game



Click here to view the game.

Clean Air



Dirty Air

Smog City K-2

GRADES
K-2

LEARNING OBJECTIVES

Students will:

- Learn what weather conditions and human activities can affect air pollution.
- Make and test hypotheses.
- Learn how changes in air quality can affect people's health.

ESTIMATED TIME

30 minutes

SUMMARY

In this activity, the class will briefly discuss how changing things such as automobile emissions and weather can affect ground-level ozone, a component of smog. The teacher then leads students through an interactive website called *Smog City* to show how raising automobile emissions can increase air pollution and how this can affect people's health. The website will help students make the connection between weather, human activities (such as driving and factory production), air pollution, and people's health.

KEY QUESTIONS

- How can cars affect air quality? *(Answer:* Emissions from car exhaust can release chemicals into the air that cause pollution.)
- How can wind affect air pollution? *(Answer:* Wind can blow air pollution away from some places and into other places. Lack of wind can keep air pollution in one place.)
- How could we reduce air pollution from cars? *(Answer:* We could drive less, and walk more.)

BACKGROUND

The word "smog" was first used in London, England, about the year 1900 to describe a combination of "smoke" and "fog" in the air. Thousands of people who lived in London died of diseases similar to pneumonia because of the poisonous smog in the air. Smog can cause health problems such as difficult breathing, asthma, eye irritation, more lung infections, and colds. Smog can also make it harder to see things far away.

Today, smog includes an air pollutant called ozone. In addition to the health problems already mentioned, the ozone in smog can damage

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plants and trees. Ozone is created when certain chemicals that pollute the air are baked by heat and sunlight and combine together to form a different substance (this is called a chemical reaction). The chemical pollutants that form ozone come from many things, including exhaust (also called emissions) released from the tailpipes of automobiles, from smokestacks of factories, and from gases released from certain chemicals in household products, such as paints.

Weather conditions can affect smog. For example, wind can blow air pollution away from some places and into other places. When there is no wind, smog may stay over a particular place for quite a while. Serious smog problems occur in many major cities and sometimes outside of cities.

MATERIALS

- Internet access
- Writing paper

STEPS

1. Review new vocabulary with students.

Review new vocabulary with the students:

- *Emissions* – Releases into the air that may contain pollution (such as exhaust from tailpipes of vehicles, which often contains several air pollutants, or releases from factory smokestacks).
- *(Ground-level) Ozone* – Formed from a combination of chemicals when baked by strong sunlight and high outdoor temperatures.

2. Demonstrate activity to students.

Demonstrate this activity first to the class prior to performing it with them, either on a computer or a projection screen. You can access the Smog City program on the Internet at: http://www.smogcity.com

3. Read about the program to students and start the program.

With students watching, click on the "Help" menu, and read to them some of the information under the heading "Here's how you control a day in Smog City" to help them understand the meaning of the "knobs" in the program. (Or, you can use "screen captures" at the end of this lesson to help explain the "Smog City" control knobs to students.) To start the program, click on "Run Smog City" on the left side of the toolbar.

4. Explain the key items.

Tell students that several things in the picture can affect whether or not smog occurs. Point out each item shown, using the computer/projection screen and the printed versions of portions of the *Smog City* website included with this lesson:

Weather conditions

- Temperature
- [Skip "inversion layer" for Grades K-2]
- Wind speed
- Whether it's a sunny or cloudy day

Population level

(Tell students: Both population levels and emission levels are things that are within the control of people, while weather conditions are not.)

Emissions levels - from:

- Cars and trucks
- Off-road vehicles
- Industry
- Consumer products

Ozone levels – Tell students that the colors shown to the right of the words "Ozone Levels" tell whether the air is clean or dirty. Green means the air is clean. Yellow means the air is medium clean, or moderate. Orange means the air is unhealthy for sensitive groups. Red means the air is unhealthy for all people. Purple means the air is dirty, or very unhealthy.

Health Effects at Peak Ozone Level – Tell students that the color here corresponds to one of the colors of the ozone-levels chart above it, and indicates the highest, or peak, ozone level for a particular day. Below this color is a section that tells the health warnings, if any, for this amount of ozone in the air.

5. Ask a predictive question about emissions, then discuss results.

Ask the students what they think would happen if you raised the emissions levels a lot from cars and trucks?

6. Raise the emission levels from cars and trucks.

Raise the emission levels as high as possible from cars and trucks only, then click "Start." *(Note:* If you try to make more than one change at a time, the results may not be accurate.)

7. Discuss results.

Ask the class: Did the change they predicted happen when you raised the emissions levels? What happened? Did the "ozone level" (green, yellow, orange, red, purple) change when you raised the emission levels for cars and trucks? (See the *Smog City* display.)

8. Discuss any health warnings.

Read to the class any health warnings associated with the ozone level in the "Health Effects at Peak Ozone Level" section. (See the *Smog City* display.)

ADAPTATION

For older students (Grade 3-5), see the *Smog City* lesson plan in this curriculum prepared for that age group.

FOR FURTHER EXPLORATION

Encourage students to continue exploring *Smog City*, either in class if time allows and/or at home, to learn more about the relationships between weather, human activities, and ozone pollution. (Note: If students will be changing additional items in the program, they will need to press "Restart" to go back to the original conditions, then make *one* change at a time, then press "Start.")

RESOURCES, ACKNOWLEDGMENTS

Smog City was developed under a U.S. Environmental Protection Agency grant and is a copyright of the Sacramento Metropolitan Air Quality Management District. Smog City is authorized for use as an educational and demonstration tool and may be downloaded for non-profit use by the general public, other agencies, associations, and educational institutions. Smog City: Copyright 1999 Sacramento Metropolitan Air Quality Management District.

MA CURRICULUM FRAMEWORKS STANDARDS

Grades K-2

Science and Technology/Engineering Curriculum

Earth and Space Science

- Earth's Materials – Understand that air is a mixture of gases that is all around us and that wind is moving air *(Learning Standard 2)*
- Weather – Describe the weather changes from day to day and over the seasons *(Learning Standard 3)*

Life Science (Biology)

- Living Things and Their Environment - Recognize that people and other animals interact with the environment…*(Learning Standard 6)*

Appendix V: Historical and Social Context for Science and

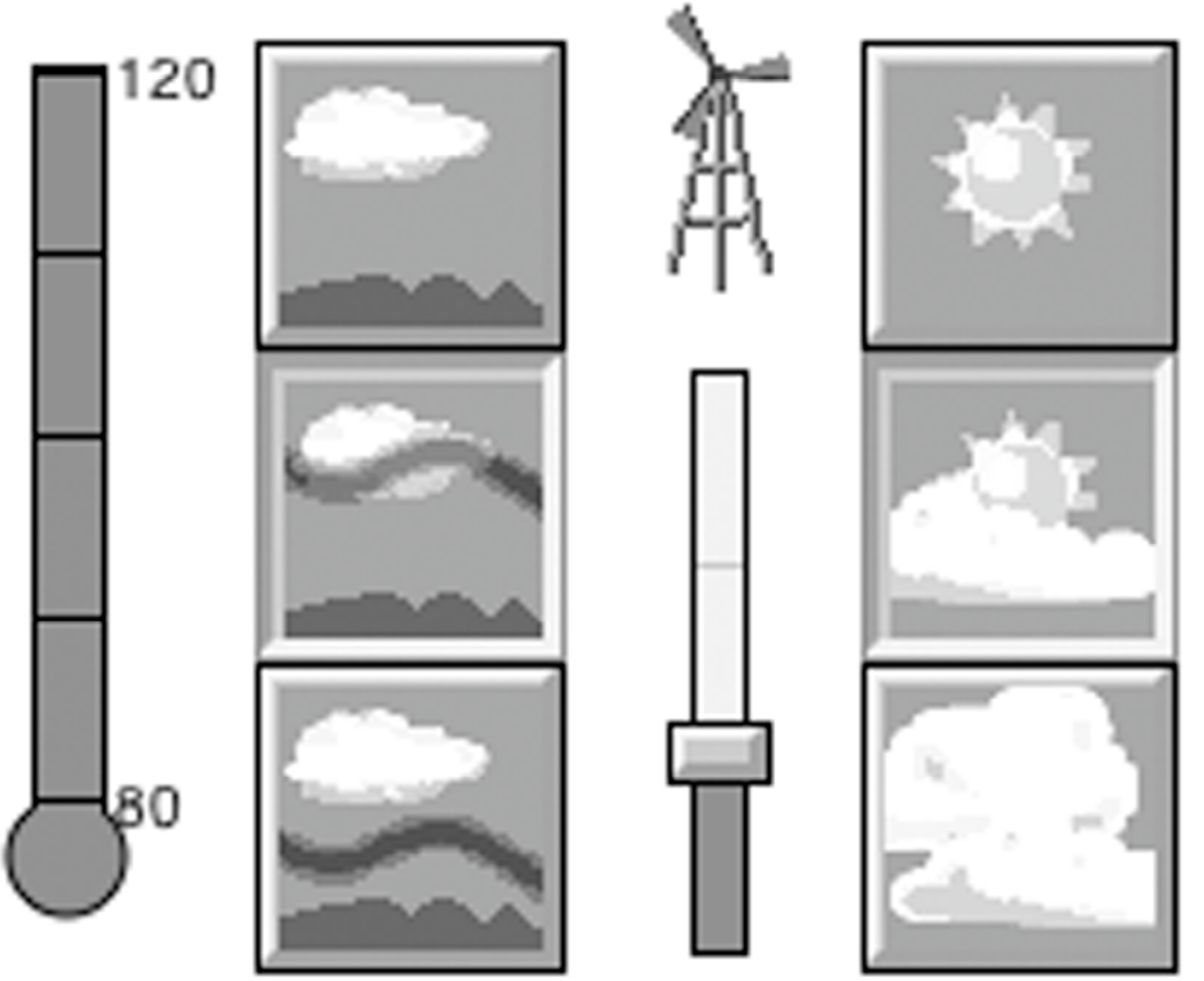
Technology/Engineering

- How government, industry, and/or individuals may be responsible for negative effects…; damage to the environment or ecosystems…; some sources of damage or pollution *(IV. Unintended negative effects from uses of science and technology/engineering)*

Comprehensive Health Curriculum

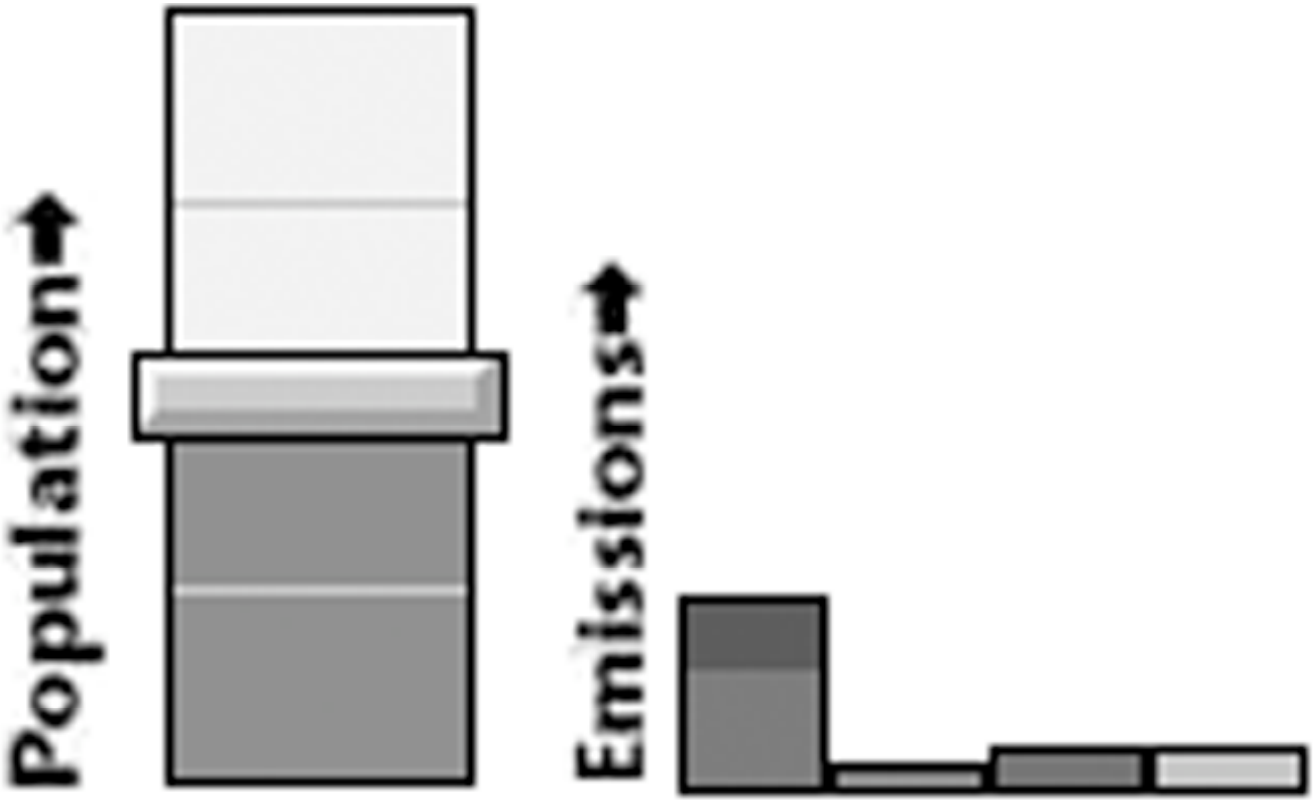
- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community *(Learning Standard 14.2)*

Select Weather Conditions

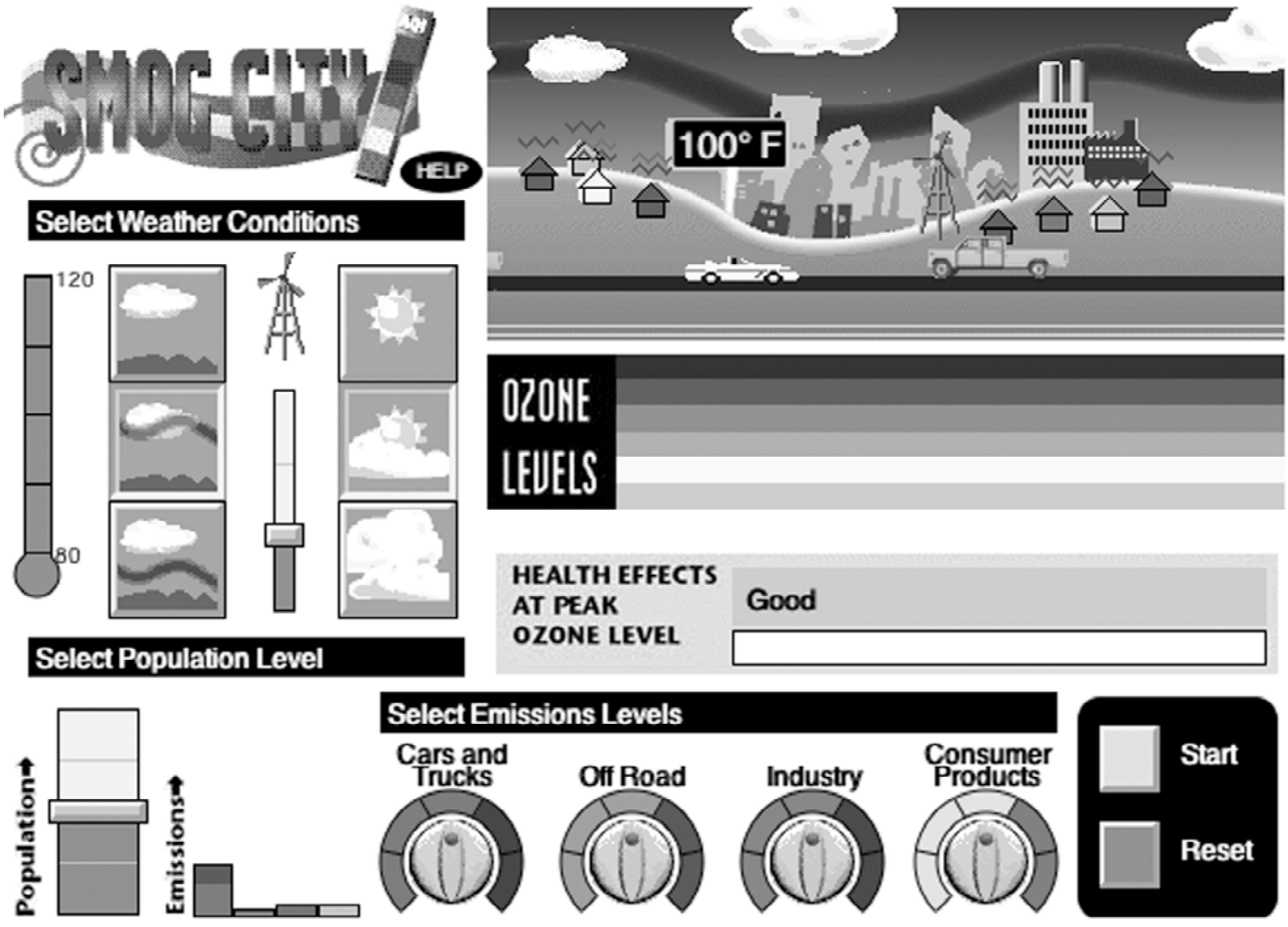


from SmogCity.com

Select Population Level



from SmogCity.com



from SmogCity.com

Lesson Plans

Grades 3-5

Breathing and Exercise

GRADES
3-5

LEARNING OBJECTIVES

Students will:

- Observe and record how breathing changes with physical activity.
- Understand the benefits of walking and other physical activity.

ESTIMATED TIME

30 minutes

SUMMARY

In small teams, students will count their breaths per minute at rest and then again after vigorously jumping up and down. The class will compare and discuss their findings.

KEY QUESTIONS

- Does a person breathe more or less during exercise than when sitting still? How much more or less (Twice as much? More? Less?)
- How can faster breathing improve our health? *(Possible answer:* It brings more oxygen to our lungs and cells.)
- Who might need to be careful about breathing faster? *(Possible answer:* People with asthma or other lung conditions)

BACKGROUND

Air is essential to life. People and other animals use the oxygen we breathe along with the food we eat to produce energy. Increased physical activity like walking, bicycling, and other exercise raises the body's energy demand for oxygen and nutrients. When we exercise, we notice an increase in our breathing rate. This is how our respiratory system helps bring more oxygen to our cells. More oxygen reaching our lungs and cells can contribute to better health. And more walking and bicycling can reduce air pollution by reducing the number of cars on the road, because cars produce air pollution.

MATERIALS

- Stopwatch, watch, clock, or timer for each team (if using the classroom clock, the teacher or a student can be the timer for the whole class, if there are not enough watches for each group)
- Student Worksheet (included)

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STEPS

1. Have students form research teams, with each student serving a different role.

Have students form research teams of 2-3 persons. In the 2-person groups, one student will time and record data while the other student will be the research subject. In the 3 person groups, one student will time, one will record data, and the last will be the research subject. If time permits, each team member can take a turn as the research subject.

2. Hand out the Student Worksheet and stopwatches (if using them) to each team, and have students answer the prediction question, "Does a person breathe more or less during exercise?"

If not using stopwatches, make sure the person acting as the timekeeper is ready. Each team will write their prediction on the Worksheet.

3. Teams will time the research subjects' at-rest breathing rates.

First, explain breathing at rest. The subject is sitting down. The timekeeper/recorder will give the subject the following instructions. "When I say start, begin counting your breaths. Breathe normally." The timekeeper tells the subject to start. After 1 minute, the timekeeper asks the subject how many breaths he or she has taken. The recorder writes the number on the Worksheet under the subject's name.

4. Teams will time the research subjects' breathing rates after jumping in place.

Explain breathing after exercise, and tell students that if they count the number of breaths for 15 seconds and then multiply by four, they can determine their ***breaths per minute.*** The timer/recorder tells the subject, "When I say start, begin jumping up and down. After 1 minute, I will say stop. Stop jumping and immediately start counting your breaths." The timekeeper tells the subject to start. After 1 minute, the timekeeper tells the subject to stop jumping and start counting breaths. After 15 seconds more the timekeeper asks for a breath count. The recorder writes the number of breaths on the worksheet and multiplies it by 4 (or by whatever method students can do this computation). The timekeeper asks the subject, "Were your breaths quicker after you exercised?" (Quicker means more breaths per minute.) The recorder writes down the answer.

(Note to Teachers: If you feel that your classroom does not have enough room for jumping, or that it might be too disruptive, students can instead stand up and sit down repeatedly for one minute. If any students are not feeling well or have a health condition that prevents exercising, they can observe or assist with timing.)

5. Repeat Steps 3 and 4 until each team member has been the subject.

If time allows for switching roles, repeat Steps 3 and 4.

6. Teams present and compare results.

Have each team make a chart showing the results of their research. Have one member of the team present their prediction and results to the class. Ask students what they notice about the results. Discuss how the results are the same, and how this shows that breathing is faster when exercising. Also discuss how this is good for our health because it brings more oxygen to our lungs. Then discuss the variety of results. What factors could cause widely varying results? (*Possible answers:* Physical condition, respiratory conditions such as asthma.) How could the results for the whole class be shown?

ADAPTATION

Have students play a quick game of basketball or walk quickly up and down a flight of stairs a few times rather than jumping up and down in place.

For Grades K-2, have the teacher test and record three students' breathing rates at rest and after exercise as examples, rather than dividing students into teams. Also have the teacher be the timekeeper rather than the students. For the last step (Step 6, Comparing Results), have the teacher (rather than the students) draw a chart of the results.

FOR FURTHER EXPLORATION

Expand the discussion to include the relationship between breathing, exercise, and air pollution. On days with poor air quality (such as high levels of ground-level ozone), an increased breathing rate may make us more vulnerable to the unhealthy impacts of air pollution. On such days, public health officials may advise people to reduce vigorous outdoor activities (such as running) and may suggest less strenuous activities instead (such as walking).

RESOURCES, ACKNOWLEDGMENTS

Adapted from the California Air Resources Board, The KnowZone.
URL: http://www.arb.ca.gov/knowzone/knowzone.htm

Also see: U.S. Environmental Protection Agency's AQI (Air Quality Index).
URL: http://www.airnow.gov
(click on "Kids" on left)

MA CURRICULUM FRAMEWORKS STANDARDS

Grades 3-5

Comprehensive Health Curriculum

- Identify behaviors and environmental factors that influence functioning of body systems *(Learning Standard 1.2)*
- Identify physical and psychological changes that result from participation in a variety of physical activities *(Learning Standard 2.4)*
- Explain the benefits of physical fitness to good health and increased active lifestyle *(Learning Standard 2.5)*

"For Further Explanation" relates to the following Health Curriculum Frameworks standards:

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community health *(Learning Standard 14.2)*
- List practices and products that make living safer *(Learning Standard 14.3)*

Student Worksheet: Breathing and Exercise

1. Prediction: Does a person breathe more or less during and after exercise such as jumping up and down compared to when not exercising?

   How much more or less? _____

2. Student A: _____ (name)

At Rest: Breaths in one minute _____

After Exercise: Breaths in 15 seconds _____ x 4 = _____ breaths per minute

Is the breathing faster after exercising? _____

3. Student B: _____ (name)

At Rest: Breaths in one minute _____

After Exercise: Breaths in 15 seconds _____ x 4 = _____ breaths per minute

Is the breathing faster after exercising? _____

4. Student C: _____ (name)

At Rest: Breaths in one minute _____

After Exercise: Breaths in 15 seconds _____ x 4 = _____ breaths per minute

Is the breathing faster after exercising? _____

5. Present your results as a chart.

Heart Rate and Exercise

GRADES
3-5

LEARNING OBJECTIVES

Students will:

- Observe and measure how and why heart rate changes with physical activity.
- Understand the benefits of physical activity.

ESTIMATED TIME

45 minutes – 1 hour

SUMMARY

In this lesson, students will take pulse rates and count heart beats at rest, and again after a few minutes of dancing vigorously. The class will compare and discuss their observations.

KEY QUESTIONS

- Have you ever felt changes in your heart beat? Why do you think your heart beat changes?
- What is the "pulse" (described below in Step #2)?
- Does a person's heart rate change during exercise compared to when sitting still? Why?
- Who might need to be careful about a faster heart rate? *(Possible answer:* People with heart conditions, although some exercise is probably good for them, under a doctor's supervision.)

BACKGROUND

Exercise is good for our hearts. Exercise reduces the chances of us getting heart disease and diabetes, helps keep us from becoming overweight, may increase how long we live, makes us feel better, and is often fun. And walking, bicycling, or doing other exercise instead of driving places can help reduce air pollution by reducing the number of cars on the road, because cars produce air pollution.

Our heart is a muscle. It becomes stronger if we exercise, which helps it pump more oxygen-rich blood to the rest of our bodies with each heartbeat. During exercise, such as walking or biking to school, our hearts help give the other muscles in our body the extra energy that exercise requires of us.

MATERIALS

- Stethoscope (optional)
- Toilet paper rolls for each team of students (to be used as stethoscopes)
- Stopwatch, watch, clock, or timer for each team (if there are not

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enough watches for each group, use the classroom clock as a timer for the whole class)
- Tape or CD player (for dancing or other form of physical activity), if available
- Student Worksheet (included)

STEPS

1. Have students form 2-person teams, then hand out materials.

Hand out the watches (if used), toilet paper rolls, and Student Worksheets to each team.

2. Demonstrate stethoscope and explain "pulse."

Hold up the stethoscope and ask students if they have seen the object before. Explain that medical personnel use a stethoscope to listen to a patient's heart. Explain to the students that a ***pulse*** can be found on parts of the body where arteries lie close to the surface. A pulse beats at the same rate as the heart. Inform students that they will find their pulse and listen to each other's heart beat during this activity.

3. Students count their own pulses and their partner's heart beats at rest.

Explain heart rate at rest. Help students locate their pulse on their wrists, using their pointer finger and middle finger (not their thumbs). Explain to students that if they count the number of beats for 15 seconds and then multiply by 4, they can determine their ***heart rate per minute.*** Instruct each student to time his/her pulse for 15 seconds, then determine the number of beats per minute. Tell the students to record their results on the Student Worksheet.

Next, have students listen to their team member's heart beat through their "stethoscopes" (toilet paper rolls), again counting the beats for 15 seconds, multiplying by 4, then recording the results on their Worksheet.

4. After a few minutes of dancing, students again count pulses and heart beats.

Explain heart rate after exercise. Tell students that soon they will dance (or, select another physical activity) to music and then measure their heart rates after this exercise. Tell students to make room for each other and not to bump into each other while dancing. (You may want to move desks aside.) (If no CD or tape player is available, have students do jumping jacks or other exercise in place.)

(Note to Teachers: If any students are not feeling well or have a health condition that prevents exercising, they can observe or assist with timing. If you feel that your classroom does not have enough room for dancing, or that it might be too disruptive, students can instead stand up and sit down repeatedly for five minutes.)

5. Have students dance (or do other exercise). Record results.

Tell the students to start dancing when the music starts, that you will tell them when to stop, and that they should time their pulse again for 15 seconds and then multiply it by 4, as before, as soon as they stop dancing. Tell them that they will record the results on their Worksheets.

Begin playing the music tape or CD, stop the music after five minutes, and tell the students to stop dancing and count their pulses for 15 seconds. Tell them to record the results.

6. Compare results.

Tell students to compare their own and their partner's heart rate before and after exercise on the student worksheet. Write some of the results on the board and discuss them as a class. Revisit some of the initial "Key Questions" above and additional questions, such as:

- Does a person's heart rate change during exercise compared to when sitting still? Why? *(Answer:* To bring more oxygen to the body. Our heart has to work harder and faster when we exercise so that it can bring oxygen and nutrients to other parts of our body.)
- Besides exercise, what other times might your heart rate increase? *(Possible answers:* Stress, fear, and excitement; fever; even after eating, to send more blood to the digestive system.)

Also discuss how increased heart rate is good for our health because it brings more oxygen to our muscles. Then discuss the variety of results. What factors could cause widely varying results? *(Answer:* Physical condition, heart conditions.) How could the results for the whole class be shown? *(Possible answer:* On a graph or chart.)

ADAPTATION

For Grades K-2, the teacher can test and record three students' heart rates at rest and after exercise as examples, rather than having the entire class do this. For the last step (Step 6, Compare Results), have the teacher (rather than the students) record the results.

FOR FURTHER EXPLORATION

- Explain heart disease (e.g., cholesterol, HDL and LDL levels, high blood pressure, coronary artery disease) and diabetes (e.g., insulin) in more detail, using previous classroom learning and/or additional available information, e.g., websites (such as:

http://adam.about.com/reports/00029_2.htm - see "Exercise"). Invite the school nurse into the classroom to give students an overview of the heart and its functions and how exercise affects the heart.

- Expand the discussion to include the relationship between heart rate, exercise, and air pollution. Carbon monoxide pollution, which comes mostly from cars, can enter the blood and can prevent it from carrying oxygen to other parts of the body. Another type of pollution, called particle pollution, comes from burning wood, windblown dust, and certain engines and factories, and can worsen certain heart-related diseases. On days with poor air quality, such as increased levels of particle pollution, an increased heart rate may make us more vulnerable to the unhealthy impacts of air pollution. On such days, public health officials may advise people to reduce vigorous outdoor activities (such as running) and may suggest less strenuous activities instead (such as walking).
- Conduct a field trip to a health club to examine different cardio-exercise equipment.
- Have students access the WebMD website on the Internet and research information on the heart and the importance of physical activity.
- Have students write a paragraph – from their heart's point of view – explaining why it is important to exercise and take good care of the heart.

RESOURCES, ACKNOWLEDGMENTS

Heart Rate and Physical Activity. The Educator's Reference Desk.
URL: http://www.eduref.org/

U.S. Environmental Protection Agency's AQI (Air Quality Index).
URL: http://www.airnow.gov
(click on "Kids" on left)

MA CURRICULUM FRAMEWORKS STANDARDS

Grades 3-5

Comprehensive Health Curriculum

- Identify behaviors and environmental factors that influence functioning of body systems *(Learning Standard 1.2)*
- Identify physical and psychological changes that result from participation in a variety of physical activities *(Learning Standard 2.4)*
- Explain the benefits of physical fitness to good health and increased active lifestyle *(Learning Standard 2.5)*

"For Further Explanation" relates to the following Curriculum Frameworks standards:

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community health *(Learning Standard 14.2)*
- List practices and products that make living safer *(Learning Standard 14.3)*

Student Worksheet:
Heart Rate and Exercise

Record your own and your partner's heart rates on this sheet.

A. Student A: _____ (name)

At Rest: Pulse in 15 seconds _____ x 4 = _____ heart rate per minute

After Exercise: Pulse in 15 seconds _____ x 4 = _____ heart rate per minute

Is the heart rate faster or slower after exercise? _____

B. Student B: _____ (name)

At Rest: Pulse in 15 seconds _____ x 4 = _____ heart rate per minute

After Exercise: Pulse in 15 seconds _____ x 4 = _____ heart rate per minute

Is the heart rate faster or slower after exercise? _____

C. Present your results as a chart.

Is the Air Good Where I Live?

GRADES 3-5

LEARNING OBJECTIVES

Students will:

- Discover that ground-level ozone occurs in many areas of the country.
- Discover that ground-level ozone problems are often associated with human activities in population centers.

ESTIMATED TIME

30 minutes

SUMMARY

This Internet activity allows students to explore the different amounts of ground-level ozone in various areas of the country and develop an understanding of why more ground-level ozone may occur in certain areas.

KEY QUESTIONS

- Do people contribute to ground-level ozone pollution when they drive cars? *(Answer:* Yes) When they ride bicycles? *(Answer:* No) When they walk? *(Answer:* No)
- In what parts of the country do you think ozone pollution might be the worst? Why? *(Possible answers:* In cities; in places where the wind has blown the ozone pollution; in places with a lot of cars and/or factories)

BACKGROUND

Ozone is a gas consisting of three oxygen atoms. There are two types of ozone: one kind is always good. This "good" ozone occurs naturally in the stratosphere approximately 10 to 30 miles above the earth's surface. This good ozone forms a layer that protects life on earth from the sun's harmful ultraviolet rays.

The other kind of ozone is bad for people and for plants if there is a lot of it. Ozone at "ground-level" – that is, in the earth's lower atmosphere – is bad if there's too much of it because it is harmful to humans, animals and plants. Ground-level ozone is a key ingredient in smog, which is a mixture of air pollutants, including gases and fine particles, that can often be seen as a brownish-yellow haze in the air. Ozone pollution can cause people to have breathing problems and can make plants weaker. Ground-level ozone comes mostly from motor vehicles that we drive, factories that make products we use, and power plants that produce our electricity. Ozone pollution is not produced directly from these sources. Rather, heat and sunlight "bake" certain chemicals (nitrogen oxides, or

NO_x, from vehicles and power plants; and volatile organic compounds, or VOCs, from gasoline-powered cars, factories, and products such as paints), which causes a chemical reaction and produces ozone. Weather is an important factor in ozone formation – the most ground-level ozone usually is formed in summertime. Also, wind can transport ozone "downwind" to other areas far from where it was formed, and pollute those areas.

An easy way to remember the two types of ozone is: "good up high, bad nearby."

MATERIALS

- Internet access
- If possible, printed color copies for students of the Air Quality Guide for Ozone (from the website below; otherwise, students can work from the Internet)
- Student Worksheets (included)

STEPS

1. Hand out copies of the *Air Quality Guide for Ozone.*

If you have been able to print color copies of the *Air Quality Guide for Ozone,* hand them out to the class.

2. Visit the ozone project's web site.

Have the class access the following Internet web site: http://www.k12science.org/curriculum/airproj/lessonscore1.html

3. Explain what the Air Quality Index (AQI) is.

Tell students that the Air Quality Index, or AQI, is an index for reporting daily air quality. It uses a simple color-coded scale to tell you how clean or polluted the air in a particular location is, and how you can protect your health at different levels of pollution. There is an AQI for ozone, and one for particle pollution. In this lesson, we are exploring the AQI for ozone only. The AQI is like a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality. *(Note:* More information on the AQI is available at www.airnow.gov)

4. View the *Ozone Map* and have students complete the Student Worksheet.

On the ozone project website, have students open the page for the *Ozone Map* and answer the questions on the attached Student Worksheet. *(Note:* In this curriculum we include a modified version of the website's Student Worksheet to help students interpret what the air quality colors mean.)

ADAPTATION

For Grades K-2, simplify the explanation of ground-level ozone in the second paragraph above under *Background* by omitting "Ozone pollution is not produced directly from these sources. Rather, heat and sunlight "bake" certain other chemicals (nitrogen oxides, or NO_x, and volatile organic compounds, or VOCs…), which causes a chemical reaction and produces ozone." Also for Grades K-2, on the attached Student Worksheet, you may want to assist the class in verbally (rather than in writing) answering questions 7-9.

FOR FURTHER EXPLORATION

- Have students explore more information about ground-level ozone from the "Links" section of the website used for this activity.
- Have students explore "nitrogen oxides" and "volatile organic compounds" (or VOCs) on the Internet.
- Obtain and have the class watch the videotape *Ozone DoubleTrouble*; this video discusses two ozone problems — the formation of too much ground-level ozone, and the deterioration of the protective upper-level ozone layer. While watching the video, students can complete a "3-2-1 Sheet" – 3 things they learned; 2 things they want to know more about; and 1 idea they want to write about. Contact information for *Ozone DoubleTrouble* video: U.S. EPA Office of Air Quality Planning and Standards (OAQPS), Education and Outreach Group at: URL: http://www.epa.gov/air/oaqps/eog/contact.html

RESOURCES, ACKNOWLEDGMENTS

Air Pollution: What's the Solution? project, developed by the U.S. EPA, the Northeast States for Coordinated Air Use Management, and the Center for Innovation in Engineering & Science Education.
URL: http://www.k12science.org/curriculum/airproj/

Also see US Environmental Protection Agency's AIRNow website at
URL: http://www.airnow.gov

MA CURRICULUM FRAMEWORKS STANDARDS

Grades 3-5

Science and Technology/Engineering Curriculum

Earth and Space Science – Weather

- Explain how air temperature, moisture, wind speed and direction, and precipitation make up the weather in a particular place and time *(Learning Standard 6)*
- Differentiate between weather and climate *(Learning Standard 9)*

Life Science (Biology) – Adaptations of Living Things

- Give examples of how organisms can cause changes in their environment…explain how these changes may affect the ecosystem *(Learning Standard 10)*

MA CURRICULUM FRAMEWORKS STANDARDS (CONT.)

Technology/Engineering

- Identify materials used to accomplish a design task based on a specific property…*(Learning Standard 1.3)*

Appendix V:Historical and Social Context for Science and Technology/Engineering Study

- How government, industry, and/or individuals may be responsible for negative effects; damage to the environment or ecosystems…; some sources of damage or pollution *(IV. Unintended negative effect…)*

Mathematics Curriculum

Patterns, Relations, and Algebra

- Use pictures, models, tables, charts, graphs, words, number sentences, and mathematical notations to interpret mathematical relationships *(Learning Standard 4.P.4)*

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community health *(Learning Standard 14.2)*

Student Worksheet:
Is the Air Good Where I Live?

Name:_____**Group:**_____

Ozone Map

Look at the "Air Quality Guide for Ozone," then look at the "Ozone Map" on the website: http://www.k12science.org/curriculum/airproj/lessonscore1.html

Then answer the following questions:

1. Next to each Air Quality category listed below, write the name of the color that is used on the map for that category:

Air Quality Category	**Color Used**
Good	
Very Unhealthy	
Unhealthy for Sensitive Groups	
Moderate	
Unhealthy	

2. Find Los Angeles, CA on the map. What is the air quality in Los Angeles? Circle:

Good Moderate Unhealthy for Sensitive Groups Unhealthy Very Unhealthy

3. Find another city on the map that has the same air quality as Los Angeles. Write the city and state below.

4. Find two cities on the map where the air quality is "unhealthy for sensitive groups." Write the city names and states below.

5. From information on the "Air Quality Guide for Ozone," list three "sensitive groups."

Student Worksheet:
Is the Air Good Where I Live? (Cont.)

Name:_____**Group:**_____

6. Are there any cities on the map with good air quality? If so, list three.

7. Where are most of the red and orange areas on the map, near or far away from cities?

8. Write a sentence that compares the kinds of places where air quality is good with the kinds of areas where air quality is unhealthy.

9. What are the cautions, or health concerns, for orange areas, where the air is unhealthy for sensitive groups? How do you think someone from a sensitive group might be affected if they lived in one of those areas?

Smog City 3-5

GRADES
3-5

LEARNING OBJECTIVES

Students will:

- Learn which weather conditions and human activities can affect air pollution.
- Make and test hypotheses.
- Learn how changes in air quality can affect people's health.

ESTIMATED TIME

30 – 45 minutes

SUMMARY

In this activity, the class will briefly discuss the impacts of different variables – such as emissions, temperature, and wind – on ground-level ozone. Then students will use an interactive website called *Smog City* to simulate different conditions and observe their impacts on ozone and human health. The website will help students make the connection between weather, human activities (such as driving and factory production), air pollution, and people's health.

KEY QUESTIONS

- Do you think automobiles affect air quality? *(Answer:* Yes. Automobiles release emissions (chemicals from their tailpipes) into the air that cause pollution. Generally, the more cars there are on the road, the more emissions there are, and the more air pollution.)
- Do you think wind affects air pollution? *(Answer:* Yes. Wind can blow air pollution away from some places and into other places. Lack of wind can keep air pollution in one place.)
- Do you think air temperature affects air pollution? *(Answer:* Yes. Increased air temperature can increase certain kinds of air pollution, which can cause health problems if people breathe it in.)
- How could we reduce air emissions from cars? *(Answer:* We could drive less, and walk more. We could drive hybrid cars.)
- How do you think we might reduce the effects of air pollution on our health? *(Answer:* We can limit the time we are active outdoors on certain days when air pollution is bad.)

BACKGROUND

The expression "smog" was first used in "Turn-of-the-Century" London around 1900 to describe a combination of "smoke" and "fog." Thousands of Londoners died of pneumonia-like diseases due to the

poisonous air. Smog can cause health problems such as difficulty breathing, asthma, reduced resistance to lung infections, colds, and eye irritation. The haze that accompanies smog reduces how far we can see into the distance (called visibility). This reduced visibility is particularly noticeable at mountains and other beautiful vistas such as national parks.

Today, smog usually contains a pollutant called ozone, among other things. Ozone is formed when certain chemicals that pollute the air are baked by the sun and undergo chemical reactions. The chemicals that form ozone come from many sources, including automobile exhaust (also called emissions), factory and power plant smokestacks, and fumes from chemical solvents in some household products, such as paints. In addition to the health problems already mentioned, the ozone in smog also can damage plants and trees.

Weather conditions can affect smog. For example, wind can blow air pollution away from some places and into other places. A lack of wind or a thermal inversion (discussed in Step 4 below) can cause smog to be trapped over a particular area. Serious smog and ozone pollution occurs in many major cities and sometimes in rural areas.

MATERIALS

- Internet access
- Writing paper

STEPS

1. Review new vocabulary with the students.

Review new terms as needed, such as:

- *Temperature inversion (or thermal inversion or inversion layer)* – A layer of warm air in the Earth's atmosphere that traps cooler air and pollution, including ground-level ozone, below it. (See diagram of a temperature inversion at the end of this lesson, also at: http://www.partnersinair.org/en/curriculum_unit1b_bkgd1.html.)
- *Emissions* – Exhaust from tailpipes of vehicles that often contains several major air pollutants, including carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NOx); some releases from industry smokestacks and consumer products are also emissions.
- *Ground-level ozone* – Ground-level ozone is formed from a combination of volatile organic compounds (VOCs) and oxides of nitrogen (NOx) in the presence of strong sunlight and high temperatures.

2. Demonstrate activity to students.

You may want to demonstrate this activity first to the class, either at a computer or on a projection screen, prior to students performing it themselves. Tell students in advance not to click on anything in the

program until you tell them to. Then have students access the Smog City program on the Internet at: http://www.smogcity.com

3. Have students read about and start the program.

Have students click on the "Help" menu and read the information under the heading "Here's how you control a day in Smog City" to help them understand the meaning of the "knobs" in the program. To start the program, click on "Run Smog City" on the left side of the toolbar.

4. Explain the key factors.

Remind students not to click on anything just yet (it's very tempting!). Tell students that several things in the picture can affect whether or not smog occurs. Mention each item shown:

Weather conditions

- Temperature
- Whether there is an inversion layer. (Explain to the class what an inversion layer is: An inversion layer occurs when the usual temperature arrangement in the atmosphere – which is warm air below cold air – is reversed, trapping pollutants along with the cooler air below the layer of warm air.)
- Wind speed
- Whether it's a sunny or cloudy day

Population level

(Tell Students: Both population levels and emission levels are things that are within the control of people, while weather conditions are not.)

Emissions levels - from:

- Cars and trucks
- Off-road vehicles
- Industry
- Consumer products

Ozone levels – Tell students that the colors shown to the right of the words "Ozone Levels" tell whether the air is clean or polluted. Green means the air is clean. Yellow means the air is medium clean, or moderate. Orange means the air is unhealthy for sensitive groups. Red means the air is unhealthy for all people. Purple means the air is very unhealthy.

Health Effects at Peak Ozone Level – Tell students that the color here corresponds to one of the colors of the ozone-levels chart above it and indicates the highest, or peak, ozone level for a particular day. Below this color is a section that tells the health warnings, if any, for this amount of ozone in the air.

5. Ask students to hypothesize, then have them raise the emission levels from cars and trucks.

Ask the students what they think would happen if they raised the emission levels a lot from cars and trucks. Then tell students to go ahead and raise the emission levels significantly from cars and trucks, click "Start," and record the results. You can choose to do this either with the class as a whole, or students can work individually. Discuss: Did the change they expected to occur happen when they raised the emissions levels?

6. Discuss results.

Ask the class: Did the "ozone level" (green, yellow, orange, red) change when they raised the emission levels from cars and trucks? (See *Smog City* display.)

7. Discuss any health warnings.

Then ask the class: Are there any health warnings associated with this ozone level? (See the *Smog City* display.) Read and discuss the health warnings in the "Health Effects at Peak Ozone Level" section.

8. Have students change other factors.

As time allows, repeat this exercise for the other items in *Smog City*, such as weather (e.g., air temperature, wind speed), population level, and/or other emission levels (e.g., off-road vehicles, industry, consumer products). Each time, before students make a change, ask them what impact they expect the change will have on ozone levels. Then have students make dramatic changes so that differences in ozone levels are more likely to occur.

Note: Students will need to press "Restart" to go back to the original conditions, then make one change, then press "Start." (If they try to make more than one change at a time, the results may not be accurate.) Ask students to observe and comment on whether their hypotheses were correct, and what resulted after these changes were made.

ADAPTATION

For younger students (K-2), see the *Smog City* lesson plan in this curriculum prepared for that age group.

FOR FURTHER EXPLORATION

Encourage students to continue exploring *Smog City*, either in class and/or at home, to learn more about the relationships between weather, human activities, ozone pollution, and health. In particular, have them open "What You'll Learn" on the homepage toolbar and perform the experiments there.

RESOURCES, ACKNOWLEDGMENTS

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MA CURRICULUM FRAMEWORKS STANDARDS

Grades 3-5

Science and Technology/Engineering Curriculum

Earth and Space Science – Weather

- Explain how air temperature, moisture, wind speed and direction, and precipitation make up the weather in a particular place and time *(Learning Standard 6)*
- Differentiate between weather and climate *(Learning Standard 9)*

Life Science (Biology) – Adaptations of Living Things

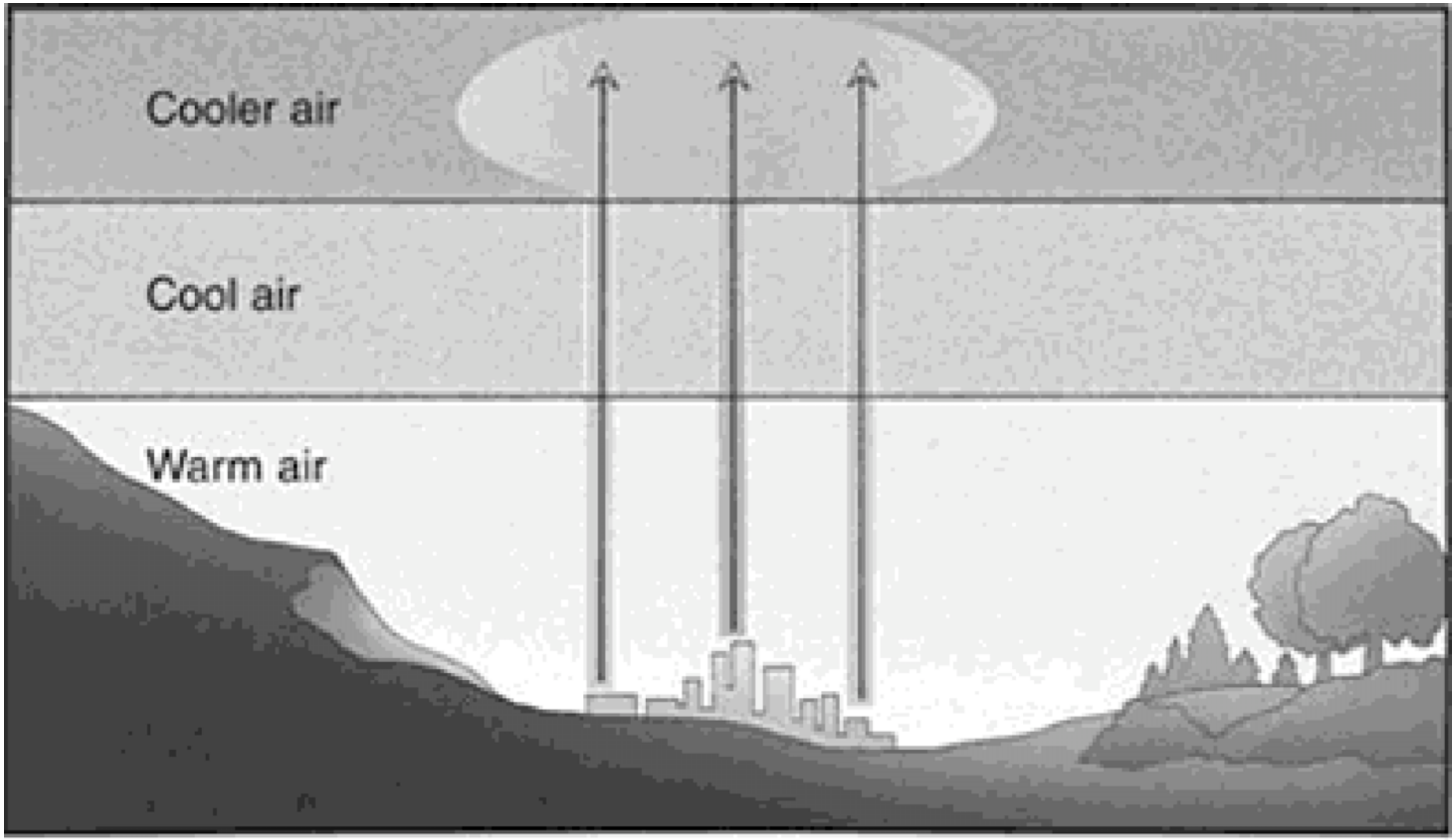
- Give examples of how organisms can cause changes in their environment…explain how these changes may affect the ecosystem *(Learning Standard 10)*

Appendix V:Historical and Social Context for Science and Technology/Engineering Study

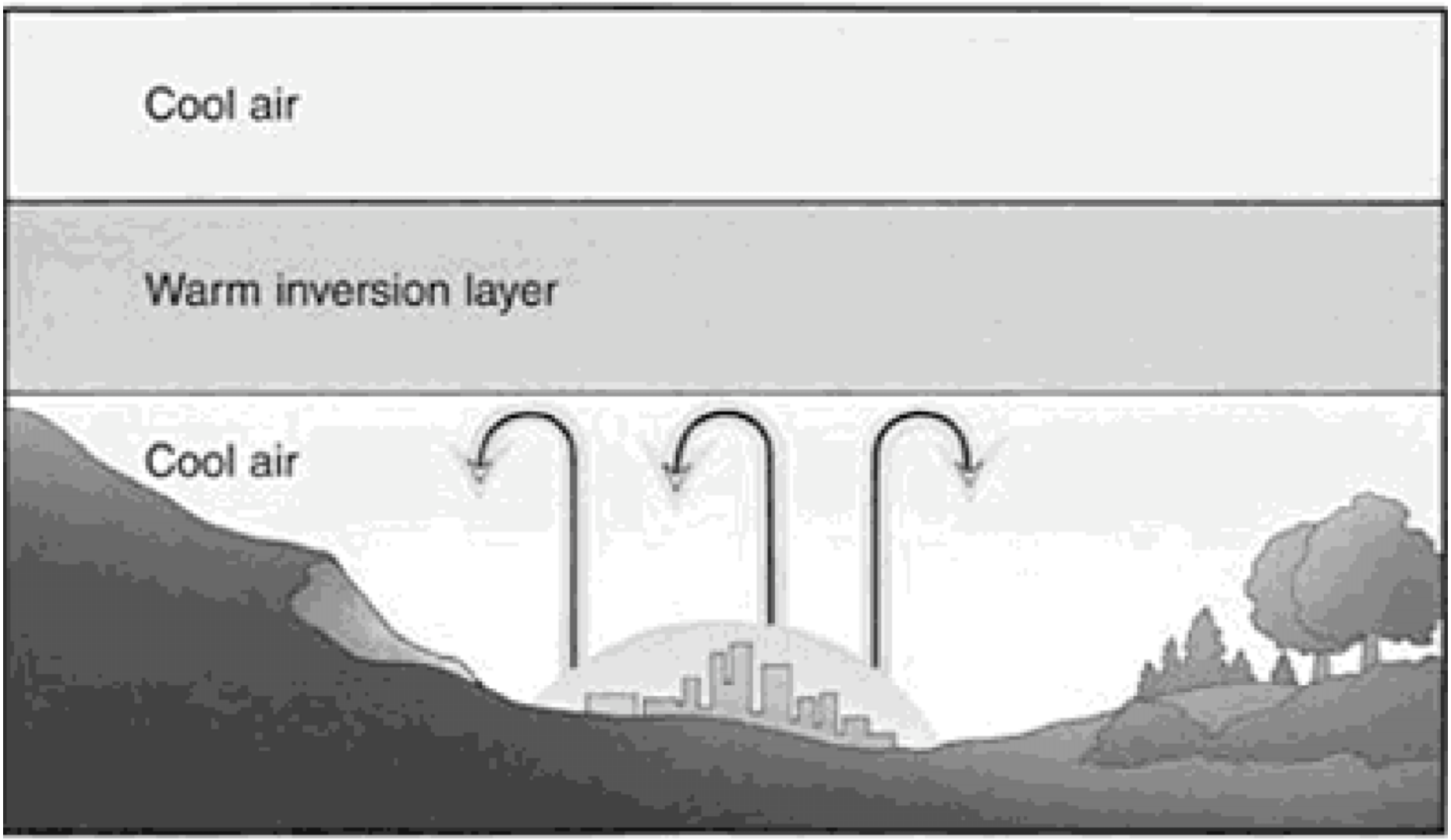
- How government, industry, and/or individuals may be responsible for negative effects; damage to the environment or ecosystems…; some sources of damage or pollution *(IV. Unintended negative effect…)*

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community health *(Learning Standard 14.2)*



Normal pattern



Thermal inversion

Traffic Tally

GRADES
3-5

LEARNING OBJECTIVES

Students will:

- Design and conduct a traffic survey to explore traffic volumes on key local roads.
- Collect, analyze, and present observational data.
- Understand the connection between vehicle traffic, air pollution, and health.

ESTIMATED TIME

Approximately 1.5 – 2 hours (2-3 sessions)

SUMMARY

This activity is a mini-field trip that provides students with hands-on experience in conducting a traffic survey in their own community, analyzing their data, and presenting it in a graphic form that shows traffic volumes.

KEY QUESTIONS

- Do you think there is too much traffic along the main (2-lane) roads in your community? If so, how many vehicles do you think travel along these roads during morning rush-hour traffic? How many people do you think are typically in each vehicle?
- How might the amount of traffic be reduced? *(Possible answers:* More people walking, bicycling, carpooling, and taking subways, trains, and buses)
- How might the amount of air pollution from this traffic be reduced? *(Possible answers:* Having fewer vehicles on the road; driving smaller or hybrid cars; more people walking, bicycling, carpooling, and taking subways, trains, and buses)
- What might be some of the benefits of reducing traffic and air pollution from vehicles? *(Possible answers:* Fewer traffic jams; safer streets to walk and bike on; fewer health problems from air pollution, such as breathing problems [e.g., asthma], and heart disease; and possibly healthier people because more people might be walking and getting exercise)
- What things might affect the accuracy of a traffic survey's results? *(Possible answers:* Bad weather; if the day was a holiday; if different groups started counting traffic at different times; if some people missed counting some vehicles; if some people put some vehicles into the wrong categories; if some people "double-counted" some vehicles)

This Safe Routes to Schools Curriculum has two purposes: To teach elementary school students—in ways that are stimulating and relevant to their lives—how walking is good for their bodies and good for the environment, while also helping teachers satisfy the requirements of the Massachusetts Curriculum Frameworks.

- What vehicles produce the most pollution per person? *(Possible answer:* Trucks, with just one person in them.) What vehicles produce the least pollution per person? (*Possible answer:* Bicycles)

BACKGROUND

Increased traffic is a chronic problem in many local communities. It is a concern because often the increase in traffic increases accidents and safety problems, decreases quality of life, and lengthens the time it takes to get places. Increased traffic is also a health and environmental concern, because more vehicles on the road means more air pollution, since gasoline-powered vehicles release pollutants such as carbon dioxide and nitrogen oxides into the air. And more air pollution can make people have breathing and heart problems. Also, driving more, instead of walking or bicycling, means we get less exercise, which can make people gain weight, which sometimes contributes to health problems such as heart problems and diabetes. Traffic is an environmental and economic concern for another reason as well: more cars on the road means more gasoline is used to run those cars. Gasoline is made from oil, of which there is a limited amount in the world.

MATERIALS

- Pencils and erasers
- Watches with minute/second hands, stopwatches, or clicker counters
- Clipboards (if available)
- Additional staff support (classroom assistants or parent volunteers)
- Signed parental consent forms (if taking students off of school premises)
- Student Worksheets (included)

STEPS

1. Preparation. ***Determine ahead of time:***

- ***Make important arrangements,*** such as obtaining parental permission slips to go to off-school locations, and getting commitments from adult classroom assistants and/or parent volunteers to accompany the class groups. *(Note: If going offsite is problematic, you can instead conduct the traffic survey on school premises, near the driveway to the school.)*
- ***Choose the roads on which the class will survey traffic volume and vehicle types.*** Choose a minimum of two roads, for comparison purposes. Choose roads that are within easy walking distance of the school, and are busy 2-lane (one travel lane each direction) roadways. Select a time of day when the roads have moderately busy traffic, such as morning rush hour. The number of roads chosen will depend on how many groups you want to divide the class into (which in turn will depend in part on how many adult assistants/volunteers you have, and the size of your class). *(Note:*

The class will not be surveying major 4-lane or larger highways; the purpose is to determine local/community traffic impacts.)

- ***Give students an overview of the traffic survey.*** Inform students that the class will conduct a traffic survey to explore traffic volumes on key local roads, and the connection between vehicle traffic and air pollution. Discuss the "Key Questions" above with the class. Tell the class that they will divide up into groups of at least 6 students per group, stand safely by the sides of different busy roads, and count the number of vehicles driving by for a fifteen-minute period (e.g., during morning rush hour). They will also identify the type of each vehicle (e.g., car, truck, etc.) and the number of people in each vehicle.
- ***Explain a tally chart.*** Tell students that to conduct the survey, they will make tally charts that keep track of the number and types of vehicles and the number of people in each vehicle, and that the class is first going to practice making these charts. On the chalkboard, illustrate tally marks: 𝍸

2. Practice a traffic tally in class.

Tell students to use the back of their Student Worksheets to practice recording the number and types of vehicles that you will list for them. Then call out the names of the vehicle types listed below; do it quickly to simulate rapid traffic flow so that students can practice performing quick tallys, which they will need to do by the roadside. For simplicity, tell students to consider SUVs and vans as "cars" and to ignore motorcycles.

Car	Car	Car	Truck	Bicycle	Truck	Car	Truck	Car	Truck
Car	Car	Truck	Bus	Truck	Bicycle	Car	Car	Car	Car
Car	Car	Bicycle	Truck	Car	Car	Car	Bicycle	Truck	Car
Truck	Car	Car	Car	Truck	Car	Car	Bicycle	Truck	Truck
Car	Car	Car	Car	Truck	Truck	Bus	Bus	Car	Car
Car	Truck	Car	Bicycle	Truck	Car	Car	Car	Car	Truck
Bus	Car	Truck	Bicycle	Car	Car	Car	Car	Car	Car

Tell students to swap tally sheets and check for correct answers for each type of vehicle as you read aloud the totals listed below.

Totals: Bicycle = 7 Car = 41 Truck = 18 Bus = 4

3. Explain roles.

Explain to students that they will conduct the survey in four pairs:

1st Pair: One person will call out loud to their partner each time a vehicle passes in *one direction* (one side of the street) the type of the vehicle (e.g., "car," "truck"), while the other partner will record the data on the Tally Student Worksheet #1.

2nd Pair: One person will call out vehicles passing *in the other direction* (on the other side of the street), while the other partner records the data.

3rd Pair: One person will call out the number of people in each vehicle *in one direction,* while the other partner will record the number of persons per vehicle. For buses, have the students determine an estimate of the number of people they will use (e.g., average of 15 people per bus) and make sure all students are using the same number.

4th Pair: One person will call out the number of people in each vehicle *in the other direction,* while the other partner will record the number of persons per vehicle. For buses, use the same estimated average number of people as discussed in "3rd Pair" above, and make sure all students are using the same number.

4. Explain methodology.

Also explain to the class that in order for the survey to be accurate, it is important that each group and each pair of students do things exactly the same way. For example, each group must start the survey at the same time, and each group must conduct the survey for exactly 15 minutes – not longer and not shorter.

5. Assign roles.

Assign the students to survey groups and assign an adult assistant to each group. Have students in each group divide up into pairs; help them decide who will be an "announcer" (calling out the type of each vehicle that passes, or the number of people in each vehicle) and who will be the "recorder" in each pair. Assign one person (perhaps the adult assistant) to be the timekeeper, who will tell students when to begin and end the survey and will record the exact starting and ending times.

6. Conduct the traffic survey.

Conduct the traffic survey at the designated locations, using Student Worksheet #1. If possible, don't have students cross any streets. Be

sure to remind students to practice safety: stand back from the roadway; if crossing a street is necessary, do so carefully when the adult assistant says it is safe to do so. Make sure students are standing in a way that allows other pedestrian to pass easily, and that they are polite to people.

7. Discuss and analyze survey results in class.

- ***Calculate totals.*** Back in the classroom (on the same day or another day), have each group add up the totals for their group, including the total number of vehicles, and the total number of each type of vehicle, using Student Worksheet #2. Also have each group add up the total number of people traveling in these vehicles. Ask a spokesperson from each group to read aloud the totals for their group, write these on the chalkboard, and add up the totals for the entire class.
- ***Discuss results.*** Compare and contrast the different categories for each group. Which roadway had the most traffic? Why does the class think this is so?
- ***Calculate different vehicle types.*** Of the total traffic, have the class calculate the portion of each vehicle type (e.g., cars, trucks, buses, bicycles). For younger students, this might be calculated as fractions. For older students, this might be calculated as fractions and percentages.
- ***Discuss the accuracy of the methodology and results.*** Identify any potential problems regarding the data collection methods: Did one group collect data for 20 minutes instead of 15? Did some people miss counting some vehicles (e.g., because they weren't paying attention, because they sneezed, etc.)? Did some people "double-count" one or more vehicles? Could students really see the number of passengers inside vehicles? Did some people put certain types of vehicles in the wrong categories? Did one group start earlier or later than another group? Did the weather suddenly change during the tally? Inform the class that any of these or other factors can affect the accuracy of the survey results. Ask the class if they have any ideas about how the survey could have been done more accurately.

8. Discuss the relationship between traffic volume, number of people in vehicles, and air pollution.

Ask: If the number of vehicles on the road were reduced, might this reduce air pollution? *(Correct answer:* Yes). Why? *(Correct answer:* Because gasoline-powered vehicles emit air pollutants, and fewer vehicles would mean less pollution.) What are some benefits from reducing air pollution? *(Correct answer:* Fewer breathing problems,

like asthma, less heart disease, and more people might get exercise by walking or bicycling instead of driving. Healthier trees and plants. Also reducing some sources [vehicles] of global warming.). Also discuss how fewer vehicles, ones that have higher miles-per-gallon, carpooling, and using public transportation would use less gasoline and thus produce less pollution.

9. Have students present the survey results.

Either the same session or on another day, tell the class that they will now prepare a presentation of the traffic survey data. Depending on time available, either assign how the class should present the data, or, if more time is available, have the class discuss different ways of presenting the data and determine the best way to present the information (e.g., line graph, pie chart, pictogram, and/or bar graph). If time permits, you may want to have different groups present their data results in different ways.

Building on prior classroom experience with the different presentation formats, explain to the class how to develop the type of presentation format you choose. Decide what units, scales, colors, symbols, spacing, etc. to use, as appropriate. If computers are available, consider having students check the Internet or use relevant software to create charts or graphs.

10. Class display.

Have the students create a class display of the survey results.

11. Discuss presentation methods.

Discuss which type(s) of chart or graph conveys the information most effectively and why.

ADAPTATION

For Grades K-2, conduct the traffic survey as a whole class instead of dividing up into groups (with enough adult classroom assistants). Have the teacher and adult assistants, rather than the students, count the number of cars and people in the cars. Back in class, the teacher can call out the totals for the students to record. For presentation purposes, help the students develop pictograms and/or pie charts (instead of more complex bar graphs, etc.).

FOR FURTHER EXPLORATION

Have students explore the mean and range of the different groups' data sets and of the grand totals. Have students develop a database, computerized if possible, of the data collected.

If your school is near a busy village business district where there is a lot of foot traffic, students can tally the numbers of pedestrians (in addition to vehicles) along a road. This exercise, and the accompanying four pho-

tographs at the end of this lesson, can show students how much less space is taken up by people on foot or bicycles than by people in cars. It can also prompt a discussion about polluting versus non-polluting modes of travel. Perform this pedestrian traffic tally at a time of day that's busy for shops and stores, such as lunchtime. Assign a fifth pair of students to count pedestrians – one student for each sidewalk along the road.

RESOURCES, ACKNOWLEDGMENTS

UK Department for Transport Primary School Teaching Resource – Numeracy: Local Traffic Survey. URL: www.databases.dft/gov.uk/primary/siteindex

The Beacon School Interactive Website – Geography Department. URL: www.beaconschool.co.uk/geography/fieldwork/home2004/trafficinfo.htm

The Tampa Tribune – "Packing Pavement," 7/18/99, by Jim Beamguard, writer, and Phil Sheffield, photographer. Photos used with permission. Complete article can be viewed online at URL: www.swt.org/share/bguard.html

MA CURRICULUM FRAMEWORKS STANDARDS

Grades 3-5

Mathematics Curriculum

Number Sense and Operations

- Add and subtract (up to four-digit numbers) and multiply (up to two-digit numbers by a one-digit number) accurately and efficiently *(Learning Standard 3.N.10)*
- Select and use appropriate operations (addition, subtraction, multiplication, and division) to solve problems…*(Learning Standards 3.N.8 and 4.N.10)*
- Add and subtract (up to five-digit numbers) and multiply (up to three digits by two digits) accurately and efficiently *(Learning Standard 4.N.12)*
- Accurately and efficiently add and subtract whole numbers and positive decimals. Multiply and divide (using double-digit divisors) whole numbers…*(Learning Standard 5.9.12)*

Patterns, Relations, and Algebra

- Use pictures, models, tables, charts, graphs, words, number sentences, and mathematical notations to interpret mathematical relationships *(Learning Standard 4.P.4).*
- Represent real situations and mathematical relationships with concrete models, tables, graphs, and rules in words and with symbols, e.g., input-output tables *(Learning Standards 5.P.4)*

Measurement

- Identify time to the minute on analog and digital clocks using a.m. and p.m. Compute elapsed time, using a clock for times less than one hour (i.e., minutes since)…*(Learning Standards 3.M.3 and 4.M.3)*

Data Analysis, Statistics, and Probability

- Collect and organize data using observations, measurements, surveys, or experiments, and identify appropriate ways to display the data *(Learning Standards 3.D.1 and 4.D.1)*
- Match representations of a data set in the forms of tables, line plots, pictographs, tallies, or bar graphs with the actual data set *(Learning Standard 3.D.2)*
- Construct and draw conclusions from representations of data sets in the forms of tables, line plots, pictographs, tallies, and bar graphs *(Learning Standard 3.D.3)*
- Match a representation of a data set such as lists, tables, or graphs (including circle graphs) with the actual set of data *(Learning Standard 4.D.2)*
- Construct, draw conclusions, and make predictions from various representations of data sets, including tables, bar graphs, pictographs, line graphs, line plots, and tallies *(Learning Standard 4.D.3)*
- Given a set of data, find the median, mean, mode, maximum, minimum, and range, and apply to solutions of problems *(Learning Standard 5.D.1)*
- Construct and interpret line plots, line graphs, and bar graphs. Interpret and label circle graphs *(Learning Standard 5.D.2)*

Science and Technology/Engineering Curriculum

Technology/Engineering Learning Standards

- Describe different ways in which a problem can be represented, e.g., sketches, diagrams, graphic organizers, and lists *(Standard 2.3)*

Appendix V: Historical and Social Context for Science and Technology/Engineering: Topics for Study

- How government, industry, and/or individuals may be responsible for negative effects. Some sources of damage or pollution *(IV. Unintended negative effects from uses of science and technology/engineering)*

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community health *(Learning Standard 14.2)*
- List practices and products that make living safer *(Learning Standard 14.3 (Public Health)*

Student Worksheet #1: Traffic Tally

Tally Sheet for Traffic Survey

Location (name of road, and main intersection if appropriate): _____

Fill out while conducting the traffic survey:

Number of Each Vehicle Type

	Tally	Totals
Cars		
Trucks		
Buses		
Bicycles		

Number of People in Each Vehicle

Cars	Trucks	Bicycles	Buses (estimate)

Student Worksheet #2:
Traffic Tally

Survey Analysis and Presentation

Location (name of road, and main intersection if appropriate): _____

Fill out in classroom after conducting survey:

Total number of cars: _____ Total number of people in cars: _____

Total number of trucks: _____ Total number of people in trucks: _____

Total number of buses: _____ Estimated total people in buses: _____

Total number of bicycles: _____ Total number of people on bicycles: _____

Total number of all types of vehicles: _____ Total number of people, all vehicles types: _____

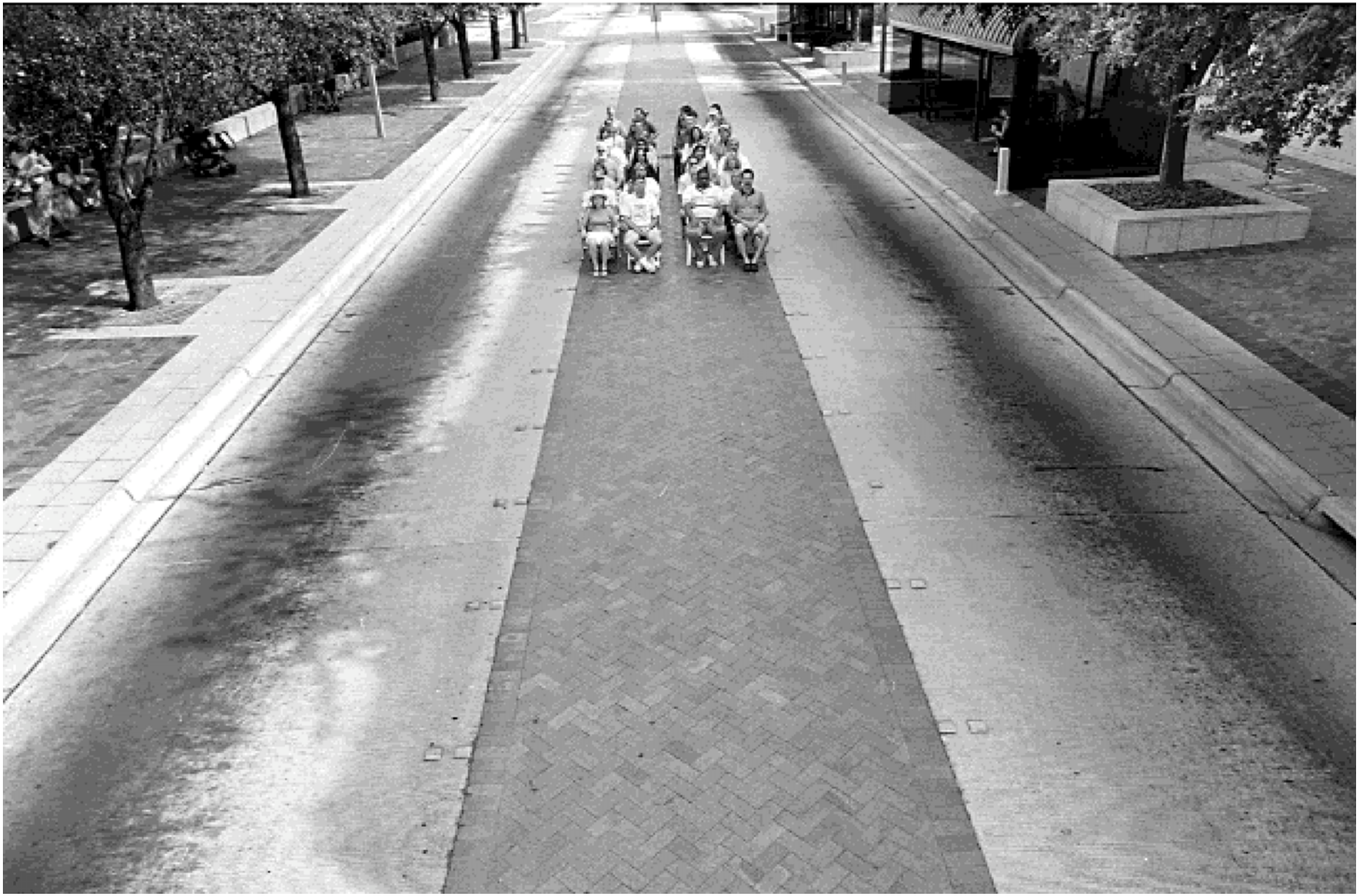
Present your survey results (as a line graph, pie chart, bar graph, and/or pictogram, as your teacher instructs you).

48 people behind the wheel of their cars.

The Tampa Tribune

Same 48 people have traded their driver's seats for chairs.

The Tampa Tribune



Same 48 people, as if they were sitting on a bus.

The Tampa Tribune

Same 48 people walking and bicycling.
So, fewer cars = More space and cleaner air!

The Tampa Tribune

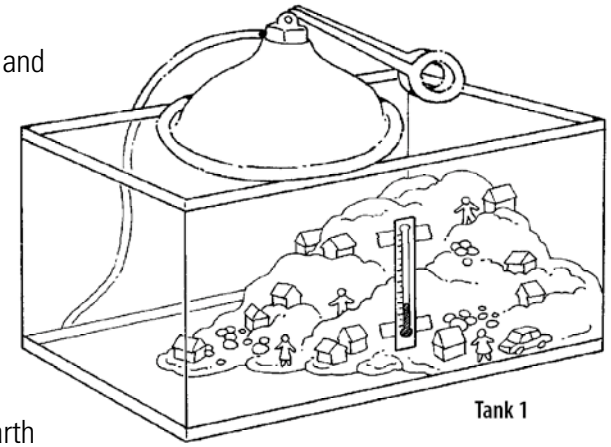
Too Many Blankets - #1

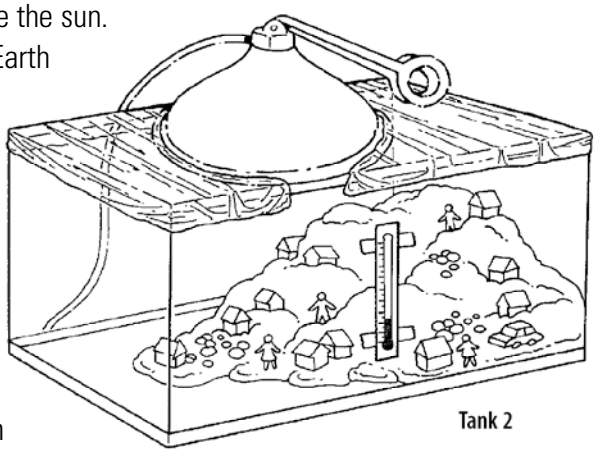
GRADES 3-5

LEARNING OBJECTIVES

Students will:

- Read thermometers and compare different temperatures over time.
- Observe how an increase in heat in the air raises the air temperature.
- Understand that the tanks are like the Earth and the lamps are like the sun.
- Understand that the Earth will grow warmer if more greenhouse gases are released into the air.
- Understand that some sources of pollution are caused by people, and that pollution can have an effect on the air and the Earth.


Tank 1


Tank 2

ESTIMATED TIME

1fi hours

SUMMARY

In this activity, students will set up two aquarium tanks with lamps to simulate the earth and the sun—one tank with no cover as the normal atmosphere, and one with a plastic or glass cover to simulate the "blanketing" effect of increased greenhouse gases. Students will observe and record how air temperature in the tank with the cover heats up more—just as greenhouse gases trap heat in the air around the Earth, causing the atmosphere and Earth to get warmer. ("Too Many Blankets - Lesson #2" extends this activity by exploring the effects of global warming, focusing on the melting of icecaps and glaciers.)

SAFE ROUTES TO SCHOOLS

This Safe Routes to Schools Curriculum has two purposes: To teach elementary school students—in ways that are stimulating and relevant to their lives—how walking is good for their bodies and good for the environment, while also helping teachers satisfy the requirements of the Massachusetts Curriculum Frameworks.

KEY QUESTIONS

- Ask students if they think that turning the lamps on will make anything happen in the tanks - you can give them a hint that it might have something to do with temperature. *(Answer:* The heat from the lamps will make the air in the tank and most things in the tank warmer.)
- Explain to students that one tank will have a cover on it and the other tank will not. Then ask: Do you think one of the tanks will heat up more than the other tank? Which one? *(Answer:* The tank with the cover will heat up more.) Why? *(Answer:* The cover traps heat in the tank.)

BACKGROUND

The air around us acts like a blanket to keep the Earth warm enough from the heat of the sun for us to live on it. But when certain gases are in the air, they might make the air and the Earth too warm. These gases are called "greenhouse gases." They trap heat in the air around the Earth, and the Earth heats up – like a glass greenhouse that people grow plants in: inside the greenhouse it is much warmer than outside of it. Having greenhouse gases in the air is kind of like adding blankets to your bed at night. The more blankets you add, the warmer you become. The more heat-trapping gases there are in the air, the more of the sun's heat is trapped, and the warmer the Earth becomes. This warming of the Earth is called global warming.

Note: If possible, set up both tanks simultaneously so that students can compare the two systems at the same time. Especially for younger students, such comparisons will provide concrete representation and observation of the abstract concept of global warming.

MATERIALS

- Two small aquarium tanks
- Glass cover for one of the tanks (or, plastic cover or plastic food-wrap)
- Modeling compound (water-resistant)
- Rocks and pebbles
- Small houses
- Small people figures and vehicles
- Two clamp lamps with 60-watt bulbs
- Two student thermometers
- Tape
- Rulers
- Clock
- Pencils
- Grease pencil or marker

STEPS

1. Create small worlds inside the two aquariums tanks.

Create small worlds inside the two aquariums using the modeling compound, rocks, pebbles, houses, figures, and vehicles. The created world should cover about half of the area inside each aquarium. Have students help: for example, ask them to place the houses where they would most like to live. Include some desirable beachfront areas along the coasts, and some potential building sites at higher elevations, as shown in the figure.

2. Position thermometer, cover, and lamps. Explain that the cover represents an increase of greenhouse gases.

Tape a thermometer to the inside center of the front of each of the tanks so that students can read them through the glass. Leave the top of Tank 1 uncovered. Cover the top of Tank 2 with the glass cover or plastic wrap. If using plastic wrap, be sure to leave enough space for the lamp in the center of the tank. Explain to the students that they should think of the tank cover or plastic wrap as part of the sky or air, and that it represents an increase of greenhouse gases.

Clamp a lamp on the center of each of the tanks. If using plastic wrap as the cover for Tank 2, place the wrap around the lamp but not under it or touching it; otherwise the plastic could catch fire.

3. Record initial tank temperatures.

Record the temperature in each tank before turning on the lamp. Using a grease pencil or marker, mark the thermometer level at the beginning of the experiment. Have students observe the initial temperatures.

4. Turn on lamps, and periodically measure temperatures.

Turn on the lamps. Record and discuss the temperatures at 1, 5, and 30-minute intervals.

5. Discuss results.

Have students view the final temperature readings, and share the results of all the temperature readings with the class. Discuss the differences in temperatures in each tank. *Ask:*

- What was the temperature at the beginning of the experiment in Tank 1?
- What was the final temperature at the end of the experiment in Tank 1?
- What was the temperature at the beginning of the experiment in Tank 2?

- What was the final temperature at the end of the experiment in Tank 2?
- Which tank had the highest final temperature?
- Why do you think the tank with the cover on top got warmer? *(Answer:* The cover trapped heat inside the tank and made the air and things in it warmer.)
- How is this experiment like the Earth and greenhouse gases? *(Answer:* Greenhouse gases trap heat in the air, and the air and the Earth get warmer.)

6. Link discussion to human activities.

Tell students that some of the things people do, like driving cars and making things in factories, release pollution into the air that increases the amount of greenhouse gases in the air. If people walked more instead of driving to places like school or the grocery store or other places, there would probably be less air pollution and less greenhouse gases, and the Earth wouldn't get as warm.

7. Link discussion to future trends.

What might life on Earth be like in 200 years if temperatures continue to increase? *(Possible answers:* The Earth and air may be very hot. Some regions may experience droughts. There may be less water on Earth.)

ADAPTATION

For older students, have the students record the temperatures. Provide a more detailed explanation of greenhouse gases and global warming.

FOR FURTHER EXPLORATION

Record the length of time it takes for each tank to reach room temperature after the lamps are turned off, and have students compare the results between the two tanks.

Read to students portions of the following books:

Johnson, Rebecca L. 1990. *The Greenhouse Effect: Life on a Warmer Planet.* Minneapolis, MN: Lerner Publications Co.

Stille, Darlene. R. 1990. *A New True Book: The Greenhouse Effect.* Chicago, IL: Childrens Press.

Also see Internet sites:
www.strategies.org
http://teachearth.com

RESOURCES, ACKNOWLEDGMENTS

Institute for Global Environmental Strategies. *The Potential Consequences of Climate Variability and Change.* Arlington, VA. Sponsored by the National Aeronautics and Space Administration (NASA) and the U. S. Environmental Protection Agency (EPA). See URL: http://www.strategies.org/climate/Blankets_May02.pdf

MA CURRICULUM FRAMEWORKS STANDARDS

Grades 3-5

Science and Technology/Engineering

Earth and Space Science – Weather

- Explain how air temperature…makes up the weather in a particular place and time *(Learning Standard 6)*
- Describe how global patterns…influence local weather in measurable terms such as temperature *(Learning Standard 8)*
- Differentiate between weather and climate *(Learning Standard 9)*

Life Science (Biology) – Adaptations of Living Things

- Give examples of how organisms can cause changes in their environment…explain how these changes may affect the ecosystem *(Learning Standard 10)*

Physical Sciences (Chemistry and Physics) – Light Energy

- Recognize that light travels in a straight line until it strikes an object…and that light can be…absorbed *(Learning Standard 12)*

Technology/Engineering

- Identify and explain the appropriate materials and tools…to construct a prototype safely *(Learning Standard 1.4)*

Appendix V: Historical and Social Context for Science and Technology/Engineering: Topics for Study

- How government, industry, and/or individuals may be responsible for negative effects; damage to the environment or ecosystems in this country and elsewhere; some sources of damage or pollution *(IV. Unintended negative effects from uses of science and technology/engineering)*

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community *(Learning Standard 14.2)*

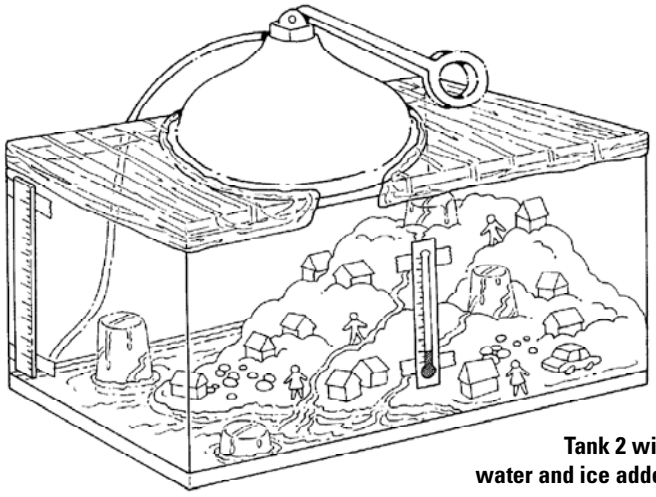
Too Many Blankets - #2

GRADES
3-5

LEARNING OBJECTIVES

Students will:

- Observe that water levels rise as ice melts.
- Measure water levels in the tanks.
- Observe that the more temperature rises, the faster ice melts.
- Understand that the tanks are like the Earth and the lamps are like the sun.
- Understand that as the Earth gets warmer as more greenhouse gases are released into the atmosphere, this may cause melting of icecaps and glaciers, which in turn may result in a rise in sea levels and flooding.
- Understand that some sources of pollution are caused by people, and that pollution can have an effect on the air and the Earth.



Tank 2 with water and ice added

ESTIMATED TIME

1 hour

SUMMARY

This activity builds on "Too Many Blankets - #1." Students will add frozen blocks of ice to the water in both aquarium tanks set up in "Too Many Blankets - #1." The ice in the tanks represents icebergs, icecaps, and glaciers in the environment. Students will observe how higher air temperature causes ice to melt faster. The class will discuss causes and implications of global warming.

KEY QUESTIONS

- Once the tanks are set up, ask: Do you think anything will happen to the ice in the tanks? What? *(Answer:* The ice will melt.)
- After explaining to students that one tank will be covered and the other tank will not, ask: Do you think the ice in one of the tanks will melt faster than in the other tank? If so, in which tank do you think the ice might melt faster? *(Answer:* The ice will melt faster in the tank with the cover.) Why? *(Answer:* The cover traps heat in the tank, which makes the temperature in the tank warmer. The warmer temperature melts the ice faster than in the other tank.)

BACKGROUND

The air around us acts like a blanket to capture the sun's heat and make the Earth warm enough for us to live on it. But when "greenhouse gases" are added to the air, they trap more heat in the air around the Earth – like adding blankets to your bed at night – and make the Earth too warm. This warming of the Earth is called global warming.

When icecaps and glaciers melt due to higher temperatures associated with global warming, sea levels may rise, and flooding might increase in coastal areas. Another change that might occur when the Earth's temperature rises is drought in some areas that get really hot.

Note: If possible, set up both tanks simultaneously so that students can compare the systems at the same time. Especially for younger students, such comparisons will provide concrete representation and observation of the abstract concept of global warming.

MATERIALS

- Two small aquarium tanks set up as in "Too Many Blankets - #1" (including lamps, thermometers, cover, and small worlds created in tanks)
- Water
- Blue food coloring (optional)
- "Icebergs" and "glaciers" (freeze water in paper cups or milk cartons; peel off paper)
- Rulers
- Clock
- Pencils
- Grease pencil or marker

STEPS

1. Set up tanks, add food coloring and water.

Set up Tanks 1 and 2 as in "Too Many Blankets - #1." Add blue food coloring (optional) to water, and carefully pour the water into both tanks, as shown in the figure.

2. Place icebergs and glaciers in tanks and measure temperature and water levels.

Place one or more icebergs and glaciers into the tanks (see figure). Take a baseline temperature in each tank. Tape a ruler to the front of each tank and measure and mark the water level on the tank glass with a grease pencil or marker. Record the data. Have students observe the baseline temperatures and water levels.

3. Position lamps and tank cover; inform class that the cover represents increased greenhouse gases in the atmosphere.

Tape a thermometer to the inside center of the front of each of the tanks so that students can read them through the glass. Leave the top of Tank 1 uncovered. Cover the top of Tank 2 with the glass cover or plastic wrap. If using plastic wrap, be sure to leave enough space for the lamp in the center of the tank. Explain to the students that they should think of the tank cover or plastic wrap as part of the sky or air, and that it represents an increase of greenhouse gases.

Clamp a lamp on the center of each of the tanks. If using plastic wrap as the cover for Tank 2, place the wrap around the lamp but not under it or touching it; otherwise the plastic could catch fire.

4. Periodically measure temperature and water level changes.

Record the temperature and water level changes in the tanks at 1, 5, and 30-minute intervals.

5. Discuss results.

Have the students observe the final temperatures and water levels, and share the results of all the temperature and water readings with the class. Discuss the differences in temperatures and water levels in each tank. *Ask:*

- What was the temperature at the beginning of the experiment in Tank 1? At the end of the experiment?
- What was the water level at the beginning of the experiment in Tank 1? At the end?
- What was the temperature at the beginning of the experiment in Tank 2? At the end?
- What was the water level at the beginning of the experiment in Tank 2? At the end?
- Which tank had the highest temperature at the end of the experiment?

- Which tank had the highest water level at the end of the experiment?
- Why do you think the water level was higher in the tank with the cover? *(Answer:* Because the cover trapped heat in the air. The warmer air melted the ice faster, which made the water level rise more.)
- Did anything happen to the land and buildings along the shoreline? *(Possible answer:* Some areas became covered by water.)
- How is this experiment like the Earth and greenhouse gases? *(Answer:* More greenhouse gases trap heat in the Earth's atmosphere and make the Earth warmer. Polar icecaps and glaciers melt and shrink as the earth's average temperature increases.)

6. Link discussion to human activities.

Tell students that some of the things people do, like driving cars and making things in factories, release pollution into the air that increases the amount of greenhouse gases in the air. If people walked more instead of driving to places like school or the grocery store or other places, there would probably be less air pollution and less greenhouse gases, and the Earth wouldn't get as warm. There also might be less flooding, droughts, or other changes in the Earth's climate.

7. Link discussion to future trends.

What might life be like on Earth in 200 years if temperatures continue to increase and more icecaps and glaciers melt? *(Answer:* The melted icecaps and glaciers could cause sea levels to rise and could cause floods and droughts. Some lands near the ocean might become flooded and covered by water.)

ADAPTATION

For older students, have the students record the temperatures and water levels. Provide a more detailed explanation of greenhouse gases and global warming.

FOR FURTHER EXPLORATION

Research and discuss icecaps and glaciers with the class.

Read to/with students portions of the following books:

Miller, Christina and Louise Berry. 1996. *Air Alert: Rescuing the Earth's Atmosphere.* New York: Athenaeum Books for Young Readers.

Pringle, Laurence. 1990. *Global Warming: Assessing the Greenhouse Threat.* New York: Arcade Publishing.

Also see the Internet site: www.ktca.org/newtons/15/greenhouse.html

RESOURCES, ACKNOWLEDGMENTS

Institute for Global Environmental Strategies. *The Potential Consequences of Climate Variability and Change.* Arlington, VA. Sponsored by the National Aeronautics and Space Administration (NASA) and the U. S. Environmental Protection Agency (EPA). See URL: http://www.strategies.org/climate/Blankets_May02.pdf

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Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community *(Learning Standard 14.2)*

How Far Do You Walk at School?

GRADES 3-5

LEARNING OBJECTIVES

Students will:

- Learn how to use and read pedometers.
- Learn to estimate and calculate how far they walk at school during typical activities using their pedometers.

ESTIMATED TIME

Estimated Time: 2 hours

SUMMARY

Students will learn how to wear and read ***pedometers,*** which count the number of steps that a person walks. They will use the pedometers to count how many steps they each walk in supervised walks in the school (or in overnight take-home exercises, if suitable for your school). Each student will calculate his or her "steps per mile" and then calculate the distance (in miles) from the number of steps that the pedometer counted. Finally, students estimate how far they might walk at school in a week.

(Note to Teachers: This activity works well as a collaboration between classroom teachers and physical education teachers.)

KEY QUESTIONS

- How far do you think you walk during a school day?
- How far do you think you walk in a typical 24-hour day?
- How do you think walking helps keep us healthy?

BACKGROUND

Walking is an easy way to get exercise every day. Walking helps keep people strong and healthy. Walking can improve people's health by helping them lose weight, increasing their heart rate and breathing rate,* and reducing the risk of diabetes. In addition, walking instead of driving can decrease traffic congestion in a community and thus help reduce air pollution.

You might walk more than you think you do. Using a pedometer is a fun way to measure how far you walk. Pedometers count the number of steps you take. Using that information, you can then figure out how far you've walked.

* Note: See lesson plans on "Heart Rate" and "Breathing Rate" in this curriculum.

This Safe Routes to Schools Curriculum has two purposes: To teach elementary school students—in ways that are stimulating and relevant to their lives—how walking is good for their bodies and good for the environment, while also helping teachers satisfy the requirements of the Massachusetts Curriculum Frameworks.

MATERIALS

- Pedometers *(Note:* For this activity, the school/class will have to have made prior arrangements for obtaining pedometers)
- Adult assistants (if possible) for each student group
- Student Worksheets (included; may be modified to suit student/teacher needs)
- Sidewalk chalk
- Pencil and paper
- 20-foot tape measure
- Calculators (optional)

STEPS

1. Describe the overall lesson.

Tell students that pedometers count how many steps a person walks. Then describe the activity as above in Summary.

2. Students estimate the number of steps to various school locations.

Ask students how many steps they think it takes to walk from the classroom to selected areas of the school and back again; choose areas such as:

- the gym
- the cafeteria
- the closest bathroom
- the playground

Tell students to write their answers on the Student Worksheet (Question #1).

3. Distribute pedometers.

Divide the class into groups of about 4 to 6 children per adult. Distribute pedometers to students, making whatever arrangements you prefer for tracking the return of the pedometers if you expect them back.

4. Instruct the class in how to *read* a pedometer.

Following the instructions that come with the pedometers you're using, instruct the class in how to read the pedometers.

Dial-face pedometers typically look like a clock, except with 10 divisions instead of 12. The long hand indicates hundreds and the short hand indicates thousands.

Digital pedometers are somewhat easier to read because they simply display the number of steps walked. However, many digital pedometers can also display miles, kilometers, calories or even a clock. Make sure that students can set the digital pedometer so it displays *steps.*

(If using dial-face pedometers, you may want to display photocopy enlargements of different pedometer readings and ask students to tell

you how many steps they represent. Also be aware that dial-face pedometers can only count to 10,000 steps and then start over again.)

Whatever type of pedometer you are using, tell students to always reset their pedometer to its "zero" or starting point before beginning. (On the dial-face pedometers, this is with both hands pointing straight up to "10.")

Students at Boston's Hurley School enthusiastically display the dial-face pedometers that they have used with physical education teacher Jim Nearhos.

5. Instruct students in how to *wear* a pedometer.

Show students how to wear the pedometers on their waists, positioned directly above the knee. Have the students put on the pedometers and walk around with them a bit to see how they move. *(Note:* In order to count steps accurately, pedometers must be worn tight on the waist to record hipbone movements. Pedometers placed on pockets or clipped elsewhere on the body will not read accurately. You may want to suggest that girls wear pants; or have on hand a few children's belts that girls can cinch around their waists over their dresses.)

6. Students practice wearing and reading the pedometers.

Tell students to walk around the gym or classroom. Check that they are wearing the pedometers correctly and can read the pedometers. If you have the students walk a fixed number of steps—such as 30 or 50 steps—the pedometers can be checked for accuracy, and any that are malfunctioning can be replaced.

7. Students walk to the chosen school locations and back, and record results.

Tell students that it is important that they walk at a normal speed and with normal steps for the results to be accurate – this is not a race.

Wearing their pedometers, have the student groups (with adult assistants) walk to one of the chosen school locations (e.g., gym, cafeteria, bathroom, playground) and back. Upon returning to the classroom, have the students record the number of steps walked on their Worksheets (Question #2). Have them do this each time they return from each of the school destinations. After all trips are finished, have students add up their own totals and write this number at the end of Question #2 on their Worksheets.

8. Review pedometer readings and compare to estimates.

Have students compare their original estimates to the actual steps they took. Have students record the differences on their Worksheets (Question #3). Discuss as a class how accurate students' estimates were.

9. Instruct students in how to calculate *distance* from "steps walked."

Students have recorded how many steps they walked. Explain that they will now use the number of *steps* they walked to calculate the *distance* they have walked in a standard unit of distance—such as *miles*.

First, students will need to know how many steps they walk in a mile. People walk different numbers of steps in a mile because our legs are different lengths: Small children with short legs will walk many more steps in a mile than bigger children with longer legs.

(Note to teachers: Pedometers that give readings in miles, kilometers, etc. are based on an average length of an *adult's* step or stride, and thus the numbers will not be accurate for children, who generally take smaller steps than adults.)

Ask students how they can figure out how many steps they each walk in a mile. *(Possible answers:* Walk a mile and count the number of steps. Count the number of steps in part of a mile and then multiply.) Students will now do the latter.

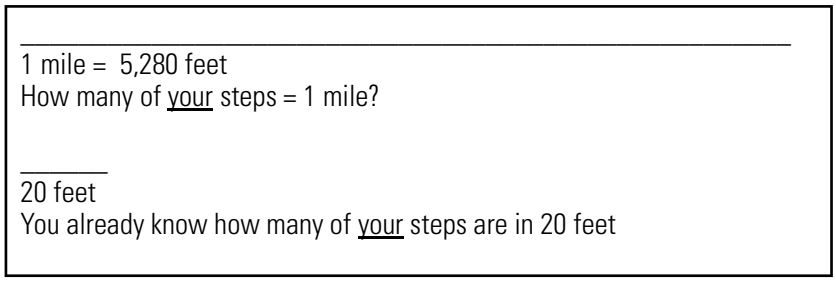
(a) ***Measure and mark off a 20-foot distance.*** The teacher and/or assistant measures a 20-foot distance and marks it off with chalk.

(b) ***Have students walk to the 20-foot mark.*** Have students line up (in small groups, if more manageable than the entire class at once) at the chalk line. Again, tell students that it is important that they walk at a normal speed for the results to be accurate: this is not a race. Tell each student to begin walking normally, and to be sure to count the number of steps they walk until they reach the 20-foot line.

(c) ***Have students record the number of steps they walked in 20 feet.*** Ask each student to record the number of steps he or she walked in 20 feet on their Worksheets (Question #4). (You can double-check that pedometer readings are within the right range.)

10. Demonstrate how to calculate "steps per mile."

Tell students that now they will calculate how many steps they walk in a mile. Give them the information that there are 5,280 feet in 1 (one) mile. Draw a long line on a blackboard and label it as shown in the graphic below. Remind students that they have just counted how many steps they each walked in 20 feet. Draw a very short line on the blackboard and label it as shown.



Now ask students if they know how to calculate how many *steps* they each walk in a *mile*.

(Give students a hint: First they can calculate how many times 20 feet goes into 5,280 feet.)

5,280 ft ÷ 20 ft = 264

(***Correct answer:*** 5,280 feet [which is one mile] divided by 20 feet [which is the distance the students walked to measure their steps] equals 264. So, in order to find out the number of steps that students walk in a mile, they need to multiply the number of steps they took by 264.)

Example Calculation:
Share an example calculation with the students before they proceed with their own calculations:

If a student named Ellen walked 14 steps in the 20-foot area, then:

14 steps x 264 = 3,696 steps per mile

11. Students calculate their own steps per mile.

Tell students to go ahead and multiply the number of steps he or she took in the 20-foot area by 264 to calculate their steps per mile, and to record this number of their Worksheets (Question #5). The teacher and/or assistants should also perform some of the calculations to check the math accuracy of the students.

12. Explain the "miles walked in school" concept.

Tell students to now look again at the total number of steps they took to and from their classroom to the different places in school that they recorded earlier on Question #2 of their Student Worksheet. Tell them they will now calculate how far (in miles) they walked to these places, and soon they will estimate how far they might walk during a typical week at school.

Example Calculation (continued):
Assist students by continuing the previous example calculation before they proceed with their own calculations:

For example, let's say our example student Ellen's pedometer said she walked 900 steps to and from class just now to all of the locations the students went to. How would the class suggest that we figure out how many miles Ellen might walk in school during a typical week?

(Correct answer for example calculation):
900 steps x 5 (school weekdays) = 4,500 steps walked per week ÷ 3,696 steps per mile* = 1.22 miles (rounded to two decimal places)

*[from Step 10 calculation]

So, 1.22 miles is the number of miles that Ellen walked each week during these school activities.

Tell students that Ellen walks almost one and one-quarter miles each week just getting around school. (Ask: If Ellen had walked exactly one and one-quarter miles, what would this number look like, expressed using two decimal points? *Correct answer:* 1.25 miles)

13. Students estimate how far they walk in school in a week.

Now have the students calculate how many miles they each walked to all of the various school locations, and estimate how many miles they might walk each week doing these activities.

Calculation for students:

_____ steps student walked today during this activity x 5 (school days) = _____ estimated steps walked per week ÷ _____ steps per mile from Worksheet Question #5 = _____ estimated miles walked each week

Have students record the approximate number of miles they walk each week during these school activities on their Worksheets (Question #6).

Congratulations! Look how far you walk during school!

14. Discuss other opportunities for walking.

Ask: Can you think of ways you walk, or could walk, even more, both in school and outside of school? *(Possible answers:* walking in gym class, walking to and from the bus, walking from home to school, from home to a store, etc.).

ADAPTATION

For younger students, omit the last phase of this activity (Steps 10 to the end: measuring distance of steps in miles), and instead give them estimates to use, such as: 600 steps =/ mile, 1200 steps = fi mile, 1800 steps = fl miles, or 2400 steps = one mile.

FOR FURTHER EXPLORATION

Coordinate pedometer readings and calculations with the Physical Education teacher.

If your school allows students to bring pedometers home, extend this activity to tracking and calculating students' walking distance over a 24-hour period.

RESOURCES, ACKNOWLEDGMENTS

PE Central
URL: www.pecentral.org

MA CURRICULUM FRAMEWORKS STANDARDS

Grades 3-5

Mathematics Curriculum

Number Sense and Operations

- Add and subtract (up to four-digit numbers) and multiply (up to two-digit numbers by a one-digit number) accurately and efficiently *(Learning Standard 3.N.10)*
- Select and use appropriate operations (addition, subtraction, multiplication, and division) to solve problems… *(Learning Standards 3.N.8 and 4.N.10)*
- Add and subtract (up to five-digit numbers) and multiply (up to three digits by two digits) accurately and efficiently (Learning Standard 4.N.12)
- Accurately and efficiently add and subtract whole numbers and positive decimals. Multiply and divide (using double-digit divisors) whole numbers…*(Learning Standard 5.9.12)*

Measurement

- Carry out simple unit conversions within a system of measurement, e.g., hours to minutes, cents to dollars, yards to feet or inches, etc. *(Learning Standards 3.M.2 and 4.M.2)*

Student Worksheet:
How Far Do You Walk at School?

1. Estimate how many steps it takes you to walk from the classroom to the following areas (or to other locations given by your teacher) and back again to the classroom:

   _____ (# of steps) to the gym
   _____ (# of steps) to the cafeteria
   _____ (# of steps) to the closest bathroom
   _____ (# of steps) to the playground

2. Now, record the actual number of steps it took you to walk to these places, using your pedometers.

   _____ (# of steps) to the gym
   _____ (# of steps) to the cafeteria
   _____ (# of steps) to the closest bathroom
   _____ (# of steps) to the playground

   TOTAL number of steps it took me to walk to all of these places and back: _____

3. What was the different between your estimated number of steps (Question #1) and your actual number of steps (Question #2)?

   The difference between estimated and actual number of steps was:

   _____ (# of steps) to the gym
   _____ (# of steps) to the cafeteria
   _____ (# of steps) to the closest bathroom
   _____ (# of steps) to the playground

4. Record the number of steps you walked in 20 feet.

   Number of steps I walked in 20 feet was _____ steps.

5. Record the number of steps you would walk in a mile.

   Calculate this by:

   _____ of steps I took in 20 feet x 264 = _____ steps in a mile

6. Estimate the number of miles you walk each week during these school activities.

   Calculate this by:

   _____ steps student walked today during this activity x 5 (school days) = _____ estimated steps walked per week ÷ _____ steps per mile from Worksheet Question #5 = _____ estimated miles walked each week

Congratulations! Look how far you walk during school!

How Much Pollution is that Car Producin'?

GRADES 3-5

LEARNING OBJECTIVES

Students will:

- Understand the connections between science (air pollution), math, and social science.
- Identify specific locations/places in the community (on maps) and local human interaction with the environment.
- Use map skills to determine distances.
- Perform calculations to determine the amount of pollution produced by car trips to school and understand how reducing car trips can reduce pollution.

ESTIMATED TIME

45 minutes

SUMMARY

This activity will help students visualize the estimated amount of pollution produced by their families' cars during typical trips to and from school, and understand how walking or bicycling can help reduce pollution. Students begin by measuring the distance between home and school on maps and then calculate the corresponding amount of pollution using the formula: 2.3 pounds of vehicle air pollutants produced per mile.[1] Finally, students measure out dry beans to visualize the amount of pollution.

[Note: Teachers may want to combine this activity with the "Walk Across Massachusetts" activity in this curriculum, since the initial steps (i.e., measuring the distance between students' homes and the school) are the same for both activities.]

KEY QUESTIONS

- How much air pollution (in pounds) do you think your car produces on a round trip to school?
- How could the air pollution your car produces be reduced? *(Possible answers:* Walking or bicycling to school; taking the bus, train, or subway; driving a smaller or hybrid car)

[1] This amount of air pollution was calculated from figures obtained from Environmental Defense's "Tailpipe Tally."

This Safe Routes to Schools Curriculum has two purposes: To teach elementary school students—in ways that are stimulating and relevant to their lives—how walking is good for their bodies and good for the environment, while also helping teachers satisfy the requirements of the Massachusetts Curriculum Frameworks.

BACKGROUND

Gasoline-powered vehicles, including cars and trucks, are one of the biggest sources of air pollution. Air pollution is frequently measured in pounds. But since air pollution is often invisible, how can we "see" the pounds of air pollution that cars produce?

For every mile the average car is driven, about 2.3 pounds of air pollution are produced. This is equivalent to about 55 pencils or 4 medium-sized hamsters! Because there are more cars now on the road than in the past, and because people drive more miles than previously—even for short trips—more air pollution is produced. People rely an awful lot on cars for getting places rather than on other forms of transportation: about 80% of trips made by people in the U.S. are made in their own cars; they carpool about 9 percent of their trips; take public transportation (such as buses and trains) about 4 percent of the time; and bicycle or walk 6.5 percent of their trips.

MATERIALS

- Copies for each student of a detailed local map of the town (if small) or school district (for larger municipalities), with a map scale, preferably with the school at the relative center. *(Note:* Local maps can often be easily obtained from the Internet or from municipal planning agencies.)
- Bin of dry beans
- A container to measure beans into
- Several pieces of string (for each or most students, cut to the 1-mile scale on the map)
- A weighing scale that measures pounds and ounces
- Small bags to put the beans in
- Colored markers
- Student Worksheets (included)

STEPS

1. Divide students into teams and distribute materials.

Separate students into several teams, and have each team collect the needed materials (maps, beans, containers, one piece of string, and small bags).

2. Have students find and mark their homes on the maps.

Have students find their homes (on their individual copies of the maps – tell them it doesn't have to be exact) and mark them with a colored "H."

3. Have teams find and mark the school on the maps.

As a team, have students find the location of the school and mark it with a colored "S" on their maps.

4. Have students measure and record the distance from home to school.

Tell students that the lengths of string represent 1 mile on the map's scale. Have students use the string, or tell them that they can use another method to measure the approximate distance from their house to the school (tell them it does not have to be exact). Have the students record this distance on their Student Worksheet. Check students' calculations for relative accuracy.

5. Have students calculate the amount of pollution produced on a car ride from home to school.

Using the formula: "1 mile = 2.3 lbs of air pollution," ask students to calculate the estimated amount of pollution produced on a car ride from their house to school. Students should calculate: "distance from my house to school x 2.3 lbs = __ lbs of air pollution." Have students write this answer on their Student Worksheet.

Tell students to calculate the air pollution produced by a *round trip* from their house to school by multiplying the above answer by 2. Tell them to write this number on their Worksheets.

6. Ask students how much pollution they produce by walking or bicycling to school.

Tell students to answer the next question on their Student Worksheet: "When I walk or bicycle to school, I produce ___ pounds (or ounces) of air pollution… *(Note: The correct answer to this portion of the question for all students is "0" pounds of air pollution.* For the next part: "…and I reduce air pollution by _____ pounds" *the correct answer is the same as their answer to the previous question on their Worksheet:* "A round trip from my house to and from school produces _____ pounds of air pollution" – *since walking/bicycling reduces all of the pollution produced by the car trip.)*

7. Have students weigh out beans to visualize pollution from their car trip.

On the weighing scale, using the container, have one member from each team scoop some beans into the container and measure the weight on the scale. Have these students add or remove beans until the weight matches the air pollution total for their round trip from home to school.

Have the students who measured their beans put the beans into small bags. Tell them they can keep the bags.

As time permits, have other students weigh out beans.

8. Compare pollution generated per trip.

Write the weights of air pollution produced per vehicle round trip for one member from each team on the board, as comparisons.

9. Discuss results.

Use one or two student's Worksheets as examples to initiate a discussion of the results. *Ask:* How much would air pollution be reduced if this person walked to school instead of being driven? (Use round trip answer.)

Then ask: How much would air pollution be reduced if everyone in the class walked or bicycled instead of drove to school? If time permits, have students add up the total. Or, to save time, the teacher can add up the round-trip numbers for the whole class, write this number on the board, and tell the students that this is the answer to the last question on their Student Worksheet ("If everyone in my class walked or bicycled to school, we would reduce air pollution by _____ pounds.")

ADAPTATION

For younger students, round the numbers—tell them that about 2 pounds of air pollution are produced for every mile their car is driven. Use one large copy of the local map for the entire class (rather than individual student maps) and measure out as averages for the whole class the distances for a few students from their home to school. You might want to have a few additional students come up to the large map and try to identify their houses and use the map scale to measure the distances to school. Also have one student (or a few) weigh out their beans, which provides a visual indication for younger students of air pollution produced by a car and reduced by walking to school.

FOR FURTHER EXPLORATION

Have students collect new car and truck advertisements, read them, and bring a few into class. Do the ads say anything about how many "miles per gallon" the vehicles get? Do they say anything about reducing air pollution? Do they talk about "hybrid" cars?

RESOURCES, ACKNOWLEDGMENTS

See iwalk International.
URL: www.iwalktoschool.org/resource.html

Easy Breathers.
URL: www.easybreathers.org/teacher/

Environmental Defense.
URL: www.Environmentaldefense.org/TailpipeTally/

MA CURRICULUM FRAMEWORKS STANDARDS

Grades 3-5

History and Social Science Curriculum

(Note: "G" means Geography)

- Use cardinal directions, map scales, legends, and titles to locate places on contemporary maps of New England, Massachusetts, and the local community *(History and Geography 4, Gr3)* (G).
- On a map of Massachusetts, locate the class's home town or city and its local geographic features and landmarks *(Cities and Towns of Massachusetts 3.8)* (G).
- Interpret a map using information from its title, compass rose, scale, and legend *(History and Geography 2, Gr4)* (G).

Mathematics Curriculum

Number Sense and Operations

- Select and use appropriate operations (addition, subtraction, multiplication, and division) to solve problems… *(Learning Standard 3.N.8 and 4.N.10).*

Measurement

- Accurately and efficiently add and subtract whole numbers and positive decimals. Multiply and divide (using double-digit divisors) whole numbers. Multiply positive decimals with whole numbers *(Learning Standard 5.N.12).*

Science and Technology/Engineering Curriculum

Appendix V:Historical and Social Context for Science and Technology/Engineering Study

- How government, industry, and/or individuals may be responsible for negative effects; damage to the environment or ecosystems…; some sources of damage or pollution *(IV. Unintended negative effects of science and technology/engineering)*
- Examples of products and systems that address negative effects *(V. How science and technology address negative effects from uses of science and technology/engineering).*

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community health *(Learning Standard 14.2)*
- List practices and products that make living safer *(Learning Standard 14.3)*

Student Worksheet:
How Much Pollution is that Car Producin'?

From my house to school is: _____ miles.

Driving from my house to school produces _____ pounds of air pollution.
(Hint: Using the estimate that 1 mile = 2.3 lbs of air pollution will help you figure this out.)

A round trip by car from my house to and from school produces _____ pounds of air pollution.

When I walk or bicycle to school instead of taking a round trip in a car, I produce _____ pounds of air pollution **(good for me!)**, and I reduce air pollution by _____ pounds.

If everyone in my class walked or bicycled to school, we would reduce air pollution by _____ pounds.

Walk Across Massachusetts

GRADES 3-5

LEARNING OBJECTIVES

Students will:

- Understand the basic concept of energy and how it relates to our getting places.
- Locate key areas on a map and measure distances that relate to their own lives and communities.
- Determine the cumulative distance traveled from taking short, local trips by foot or bicycle.
- Identify the benefits (personal, environmental, societal) of traveling in ways other than single occupancy vehicles.

ESTIMATED TIME

45 minutes (first session)
Homework (up to one hour over a week)
1.5 hour (second session)
Additional 45 minute sessions (until students have "walked across" Massachusetts)

Notes to Teachers: This activity is most effective during warmer-weather months. Also, consider doing this activity after *How Much Pollution is that Car Producin'?* which helps students understand auto emissions. The initial steps for both activities are the same (i.e., measuring the distance between students' homes and the school).

SUMMARY

This activity helps students understand that even short local walking trips can add up to a lot of miles and a big reduction in auto emissions. In class on a local map, students measure the distances between their homes and the school and a few other sample destinations, such as the town library or a local store. Then, for a week-long homework assignment, each student keeps a record of the distances walked to school and elsewhere. Any mode of travel "with their own feet" counts: bicycling, skate boarding, scooters, as well as walking. At the end of the week, students bring their worksheet/travel diaries in to school and total up the distances they walked. Then on a large map of Massachusetts, they plot the total distance walked by the class, starting at the eastern edge of the state. Week by week, they plot the class's total miles walked as they make their way westward across the state, a total of 246 miles (by road from Provincetown to Richmond).

This Safe Routes to Schools Curriculum has two purposes: To teach elementary school students—in ways that are stimulating and relevant to their lives—how walking is good for their bodies and good for the environment, while also helping teachers satisfy the requirements of the Massachusetts Curriculum Frameworks.

(Note to teachers: This lesson gives students "credit" for carpooling and using public transit, but the focus is on physical activity.)

KEY QUESTIONS

- Which way of traveling that we've discussed (see *Background)* uses the most energy? *(Answer:* A car with one person in it) The least? *(Answers:* Walking, bicycling)
- What are some of the good things about getting places by walking or bicycling instead of by car? *(Answers:* Exercise, reducing energy use, reducing air pollution)
- What are some ways that you and your family might reduce energy use and air pollution by changing how you get places? *(Possible answers:* Walk or bike to school or a friend's house instead of driving; carpool to soccer games; buy hybrid fuel cars instead of ones that only use gasoline; buy smaller cars that use less gas)

BACKGROUND

Going places—whether by walking, bicycling, or riding in a car—requires energy. Energy is the ability to do work. When we go places by car, we burn gasoline, which is a non-renewable form of energy known as a fossil fuel that can cause pollution. When we walk or bicycle, we "burn" calories, which is also a form of energy use, but one that causes no pollution. When we walk or bike instead of drive somewhere, we use less gasoline in our cars, and we save energy. Carpooling[1] or riding a bus, subway, or train uses less energy than getting places in cars with just one or two people in them.

The different ways we travel and use energy can affect us, and sometimes many other people, in a number of ways:

- When we walk or bike, we get exercise, which is good for our health.
- We also reduce air pollution when we walk or bicycle instead of drive places. Reducing air pollution is important because air pollution can make us sick and can harm the environment. Carpooling or riding a subway, train, or bus generally creates less air pollution than driving in cars.
- Walking and biking also reduce car trips, and traffic jams!

You may be surprised at how far we can travel without driving. This exercise will show you how you can walk or bicycle across Massachusetts!

[1] You might want to define carpooling as two or more families who share driving; large families are not a carpool, and a carpool must eliminate at least one car trip.

MATERIALS

- Large map of the Commonwealth of Massachusetts (with scale) to post in classroom
- Copies (8 fi x 11-size) for each student of a local map of the town (if small) or school district (for larger municipalities), with school at relative center, many streets identified, and a clear, easy-to-use map scale *(Note:* Local maps can often be obtained from the Internet or municipal planning departments)
- (Optional) Large map of the local map distributed to students (described above) to post in classroom
- Colored string/yarn
- Push pins
- Colored markers
- Student Worksheet (included)

STEPS

1. Display the map(s) and explain the project.

Post the map of Massachusetts in a prominent place in the room. Explain the activity as described above in *Summary.*

2. Have students mark their homes and school on individual maps.

Pass out the 8 fi x 11 copies of the local map to students and, if you choose to, post the large local map. Ask students to identify approximately where they live on the map, mark their home with a colored "H", and draw a colored line from their house to the school, which they should mark with an "S". Ask one or two students to demonstrate on the large local map.

3. Have students measure the distances from home to school.

Next, using the map scale on their individual local maps, have the students measure the distance in miles that they just marked between their homes and the school. Have the students record the distance on the Student Worksheet. Then ask students to name a couple of other places in town that they might walk or bicycle to. Tell students to record these distances on their Worksheets. Ask one or two students to mark their destinations on the large local map and measure the distances.

(Note to teacher: Students may need teacher assistance in using map scales. Make sure that students can measure and record map distances on their own because they will need to do this in the next *Step.* However, if time is limited, you can instead show the class how this is done, and select an "average" distance from home to school that the students can use.)

4. For a week, have students measure and record the distances they travel "with their own feet."

Tell the students to bring their maps and worksheets home and to record on the worksheets some of the places to which they walk and bicycle (with their parents' permission, of course, and probably often accompanied by an adult). Remind them that any mode of travel "with their own feet" counts, including walking *to and from* a bus or train. Instruct them to calculate and record on their worksheets the distance of each of these trips, as best as they can (they don't have to be exact), using the scale on their local maps. Suggest that students ask their families if they need help using the map scales.

Tell students to try to include more than one destination for each day. (You may want to give students two or three copies of the worksheet so they have room to record several trips each day). Remind students to only include travel by walking and bicycling (and other travel "with their own feet") unless they go by carpool or public transit. Explain that because traveling by carpool or bus, train, or subway reduces gasoline use and air pollution compared to riding in individual cars, they will get a bonus mile added for every trip they make in these ways.

Tell students that in a week they will use the distances they record to "Walk Across Massachusetts" on the state map that is posted in the classroom.

5. In class have students total up their miles traveled.

At this point the class needs to calculate the *total miles traveled* by all the students' walking or bicycling during the week. (You may want to break the class into small groups to calculate subtotals before calculating a grand total on the blackboard. Do whatever works best for your size class.)

To give students credit for carpooling and using public transit, have them total up the number of *trips* (not miles) made by carpool or public transit in the "Trips" column on their Worksheets. Then, add one bonus mile for each carpool/transit trip to class's total miles walked and bicycled.

6. Plot how far the class traveled on the map of Massachusetts.

Using the map scale on the large map of Massachusetts, cut the colored string to the length of the total miles the class traveled that week *(as calculated in Step 5)*. Discuss proportional map scales with the class, comparing the scale on the students' small local maps to the scale on the large map of Massachusetts.

Pin one end of the string to Provincetown and extend the string as far as it will go towards the western end of the state. Pin the other end of the string in place. (Alternatively, you can use a map measurer and a colored marker instead of string.) Show the students how far they traveled, allowing them to examine the map as time allows.

7. Discuss how going places "with our own feet" saves energy and reduces pollution.

Discuss with the class all the different places they traveled "with their own feet." Ask students what they liked about walking or bicycling. Ask them which ways of traveling around town reduce energy use and reduce air pollution.

8. Repeat each week, until the class has "walked across Massachusetts."

As time permits, repeat steps 4 through 6 during the following weeks. Ideally, repeat these steps until the students have "walked across Massachusetts," which is a total of 246 miles (east to west by road from Provincetown to Richmond).

ADAPTATION

For younger students (Grades K-2), instead of having them take maps home to record trips, pick two or three trips they are likely to make during the week, such as from home to school and from home to the supermarket. Ask students to keep a list of how many trips to each of these places they make during a particular week, and how they got there (walked, bicycled, rode in a car, took a bus, etc.). Estimate reasonable distances for these trips (e.g., one-half mile from home to school, one mile from home to the grocery store, etc.) and use these assumed distances as miles for the "Walk Across Massachusetts" map (rather than actual miles traveled).

FOR FURTHER EXPLORATION

This activity adapts readily to children using pedometers to track daily miles walked. *See How Far Do I Walk at School?* for conducting a pedometer activity.

If a teacher wants to make this activity last longer and cover more territory—or if an entire grade or even an entire school will participate—then "Walk Across America" or "Walk the Appalachian Trail" may be suitable and may offer richer History and Geography material.

- For "Walk Across America" see *Resources* below.
- For "Walk the Appalachian Trail"—a 2,174-mile footpath—see the National Park Service website to download a map: http://www.nps.gov/appa/pphtml/maps.html#

Tally each individual student's mileage, and award a prize to the student who traveled the farthest without car trips. Emphasize that the prize is for getting a lot of exercise, saving energy (by using less gas for car trips), and reducing pollution (by sending less pollution into the air from car exhaust).

Instead of taking the most direct route to "Walk Across America," students can choose to visit a particular place each week that their accumulated miles can take them. The class can then do research to find out something interesting (e.g., historical) about that location.

RESOURCES, ACKNOWLEDGMENTS

Walk and Bike Across America. Way to Go Program, British Columbia.
URL: www.waytogo.icbc.bc.ca

Walk and Bike Across America, an online educational activity for grades 4-12. Marin County, CA, Safe Routes to School program.
URL: http://www.saferoutestoschools.org/walk/

Going Places, Making Choices: Transportation and the Environment curriculum. National 4-H Council.
URL: http://www.4hgpmc.com

MA CURRICULUM FRAMEWORKS STANDARDS

Grades 3-5

History and Social Science (note: G = Geography)

Massachusetts and its Cities and Towns: Geography and History

- Use cardinal directions, map scales, legends, and titles to locate places on contemporary maps of New England, Massachusetts, and the local community *(G, Gr 3, Concepts and Skills - History and Geography 4).*
- On a map of Massachusetts, locate the class's home town or city and its local geographic features and landmarks *(G, Gr 3, Learning Standards – Cities and Towns of Massachusetts 3).*
- Interpret a map using information from its title, compass rose, scale, and legend *(G, Gr 4, North American Geography.Concepts and Skills – History and Geography 2).*

Mathematics Curriculum

Number Sense and Operations

- Add and subtract (up to four-digit numbers) and multiply (up to two-digit numbers by a one-digit number) accurately and efficiently *(Learning Standard 3.N.10)*
- Select and use appropriate operations (addition, subtraction, multiplication, and division) to solve problems…*(Learning Standards 3.N.8 and 4.N.10)*

- Add and subtract (up to five-digit numbers) and multiply (up to three digits by two digits) accurately and efficiently *(Learning Standard 4.N.12)*
- Accurately and efficiently add and subtract whole numbers and positive decimals. Multiply and divide (using double-digit divisors) whole numbers…*(Learning Standard 5.9.12)*

Patterns, Relations and Algebra

- Solve problems involving proportional relationships, including… map interpretation *(Learning Standard 4.P.5)*

Science and Technology/Engineering Curriculum

Life Science (Biology) – Adaptations of Living Things

- Give examples of how organisms can cause changes in their environment…explain how these changes may affect the ecosystem *(Learning Standard 10)*

Appendix V: Historical and Social Context for Science and Technology/Engineering: Topics for Study

- How government, industry, and/or individuals may be responsible for negative effects…damage to the environment or ecosystems in this country and elsewhere; some sources of damage or pollution *(IV. Unintended negative effects from uses of science and technology/engineering)*
- Examples of products and systems that address negative effects *(V. How science and technology address negative effects from uses of science and technology/engineering)*

Comprehensive Health Curriculum

- Describe types of natural resources and their connection with health *(Learning Standard 13.1)*
- Identify ways the physical environment is related to individual and community *(Learning Standard 14.2)*

Student Worksheet:
How I Travel With My Own Feet

Name: _____

Distance (in miles) from my house to school _____

Distance to _____: _____ miles

Distance to _____: _____ miles

Example

Day	*Traveled from…to…*	*Traveled by…*	*Distance (miles, approx.)*	*Trips*
Monday:	home to friend's house	bike	1.0 miles	
Tuesday:	home to school	walk	0.5 miles	
Wednesday:	home to football game	bus		1
Friday:	home to the movies	walk (part)	3.0 miles	
		subway (part)		1

Day	*Traveled from…to…*	*Traveled by…*	*Distance (miles, approx.)*	*Trips*
Monday	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Tuesday	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Wednesday	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Thursday	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Friday	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Saturday	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Saturday	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____

Total (to be done in next class):

Number of miles traveled by walking and biking: _____

Number of trips taken by carpool, bus, subway, and train: _____

Bibliography

COMPREHENSIVE HEALTH

Active & Safe Routes to School, Walk to School Day, links and resources for Teachers — iwalk International. Includes classroom activities that link to the Ontario Curriculum (Canada). Website URL: www.iwalktoschool.org/resource.html

Centers for Disease Control — Prevalence of Obesity and Overweight Among Adults: United States 1999-2000. Data from National Health and Nutrition Examination Survey 1999-2000. National Center for Health Statistics. URL: www.cdc.gov/

Eat Well & Keep Moving — *Harvard School of Public Health.* Curriculum that covers healthy eating and health/physical education activities, including walking. Contact: Human Kinetics, 800-747-4457 or Website URL: www.humankinetics.com/products/showproduct.cfm?isbn=0736030964

The Great Body Shop — *Children's Health Market.* Research-based health curriculum program for pre-K through middle school. Website URL: www.thegreatbodyshop.net/

Health information websites, such as — Website URL: http://adam.about.com/ (e.g., search on "heart disease," "diabetes," and "exercise")

Institute of Medicine of the National Academies — Childhood Obesity in the United States: Facts and Figures. 2004. URL: www.iom.edu/

Kids Walk-to-School — *Centers for Disease Control (CDC).* A community-based program developed by CDC's Nutrition and Physical Activity Program. Website URL: www.cdc.gov/nccdphp/dnpa/kidswalk/

PE Central — Provides current information on developmentally appropriate physical education programs for children and youth. Website URL: www.pecentral.org

Safe Routes to Schools, Teachers Resource Pack — *Sustrans Routes for People.* Activities for primary and secondary levels in England. Links to several curricula. Also includes transportation facts, figures, and questionnaires. Website URL: www.saferoutestoschools.org.uk/

Safe Routes to Schools Tool Kit Manual — *WalkBoston.* Includes background information on safe routes to schools programs, a case study, step-by-step discussion of how to organize a program in your community, classroom activities, and sample forms and surveys. Website URL: www.walkboston.org

HISTORY AND SOCIAL SCIENCE

Going Places, Making Choices — *National 4-H Council.* High school curriculum that raises awareness about transportation, personal mobility choices, and the environment; interdependency between economic, environmental, social, and political concerns; natural resources and energy use; global climate change; land use; and personal choices and community action. Website URL: www.4hgpmc.com/

National Highway Transportation and Safety Administration — Building Safe Communities - Safe Routes to Schools. 2001. Vol. 5 No. 1. URL: www.nhtsa.dot.gov

Traffic Survey — The Beacon Geography Department. Website URL: www.beaconschool.co.uk/geography/fieldwork/home2004/trafficinfo.htm

Walk and Bike Across America — *Way to Go Program, British Columbia.* Website URL: www.waytogo.icbc.bc.ca

Walk and Bike Across America — *Marin County, CA, Safe Routes to School program.* Website URL: http://www.saferoutestoschools.org/walk/

MATHEMATICS

Primary and Secondary School Teaching Resource — *UK Department for Transport.* Teaching resources for primary and secondary school teachers on road safety-related topics. www.databases.dft.gov.uk/lessonplans/

Pedometer Lesson Plan — Website URL: www.thepedometercompany.com/books.html

SCIENCE AND TECHNOLOGY/ENGINEERING

Air Curriculum Resources, Teacher Center — *U.S. Environmental Protection Agency (EPA).* Lists and describes several curriculum-related sites, including the SunWise Schools Program, several listed below (Project A.I.R.E.; Easy Breathers; and Air Pollution, What's the Solution?), and others. Website URL: www.epa.gov/teachers/curric-air.htm

AIRNow — A multi-agency government website that provides the public with easy access to national and local air quality information. Includes Kids and Teachers sections. Website URL: www.airnow.gov

Air Pollution, What's the Solution — *U.S. EPA.* Curriculum unit on ground-level ozone for grades 6-12. Website URL: www.k12science.org/curriculum/airproj/

Air Quality Lesson Plans and Data — *Texas Natural Resource Conservation Commission (TNRCC).* Numerous air quality-related lesson plans for grades 1-12. Website URL: www.tnrcc.state.tx.us/air/lesson_plans.html

Easy Breathers — *Wisconsin Department of Natural Resources.* Covers pollution emissions from transportation sources, including topics such as global warming, climate and greenhouse gases, average vehicles occupancy in your community, and air issues: a community survey. References relevant primary national (U.S.) academic standards. Website URL: www.easybreathers.org/teacher/

The Educator's Reference Desk — *Information Institute of Syracuse.* Numerous lesson plans (e.g., Heart Rate, Breathing), links to resources, and answers to education questions. Website URL: www.eduref.org/

Engineering Planet — *Rutgers Engineering.* Lessons developed by middle school teachers and university faculty on current science and technology (including pollution and environmental) issues. Website URL: www.engineering-planet.rutgers.edu

EPA Student Center, Air — *U.S. EPA.* Covers a variety of topics such as global warming, acid rain, ozone, and UV radiation. Website URL: www.epa.gov/students/air.htm

Environmental Education for Kids — *Wisconsin Department of Natural Resources.* Electronic magazine for Grades 4-8 that includes teaching activities and educational resources. Website URL: www.dnr.state.wi.us/org/caer/ce/eek/

The KnowZone — *California Air Resources Board.* Provides teaching materials and information on air quality and environmental issues. Website URL: http://www.arb.ca.gov/knowzone/knowzone.htm

Polar Bear Fan Club — URL: www.polarbear.org.uk/

The Potential Consequences of Climate Variability and Change — *Institute for Global Environmental Strategies.* For grades 1-12, age-appropriate activities covering greenhouse gases and their effect on agriculture, coastal areas, forests, human health, and water. Website URL: www.usgcrp.gov/usgcrp/nacc/default.htm

Project A.I.R.E. — *U.S. EPA New England.* Large set of student activities, exercises, and background reading materials for teachers and students in grades K-12. Topics include air quality, rainforests, radon, environmental laws, the greenhouse effect, and ozone. Website URL: www.epa.gov/region01/students/teacher/aire.html

Science Topics — *Eisenhower National Clearinghouse for Mathematics and Science Education (ENC),* a K-12 math and science teacher center, allows online searches by key word to find a variety of science web sites with lesson plans and activities. Website URL: www.enc.org/

Smog City — *Sacramento Metropolitan Air Quality Management District.* An interactive air pollution simulator game that shows how people's choices, environmental factors, and land use contribute to air pollution. Website URL: www.smogcity.com/welcome.htm

Tailpipe Tally — *Environmental Defense.* Interactive tool that calculates consumption, fuel cost, and vehicle emissions for different vehicle models. Website URL: www.Environmentaldefense.org/TailpipeTally/

SAFE ROUTES TO SCHOOLS

This Safe Routes to Schools Curriculum teaches students, through stimulating and relevant lessons, how walking is good for their bodies and the environment. For teachers, it satisfies the Massachusetts Curriculum Frameworks requirements.



REDUCE TRAFFIC | CREATE WALKABLE COMMUNITIES | PROTECT THE ENVIRONMENT | PROMOTE EXERCISE FOSTER INDEPENDENCE | AWAKEN STUDENTS' MINDS

walkBoston
www.walkboston.org

ERG
www.erg.com