

LESSON PLAN
~Science, Grade 10, Academic~

**“The Sustainability of Ecosystems:
The Clean Air Game”**

-created by Lynn Perreault, Ph.D. (for Idle-Free Windsor)

Date:	Time:
School:	Teacher:
Special Instructions:	

Ontario Curriculum Connection

By the end of this course, students will:

Overall Expectation:

- Analyze issues related to environmental sustainability and the impact of technology on ecosystems.

Specific Expectations (Relating Science to Technology, Society, and the Environment):

- Assess the impact of technological change and natural change on an ecosystem (e.g., the effect of polluted water or air on plants and animals).

MATERIALS & EQUIPMENT:

Playing pieces (e.g., one fruit loop per student);

Dice (one per game board);

Game boards which may be enlarged to fit a laminated 11" x 17" sheet of paper

(see Appendix 1 -> there should be approximately 4 to 5 players per game board); and

One photocopy of Appendix 1 for each student to use as a resource for the discussion.

Vocabulary:

Words & concepts your class may be learning

CO: Carbon monoxide is a gas that is emitted from an automobile, for example.

CO₂: Carbon dioxide is a greenhouse gas that is emitted from an automobile, for example.

HAPs or Toxics: Hazardous Air Pollutants come from burning fossil fuels such as wood.

NOx: Nitrogen oxides come from burning fossil fuels at high temperatures, for example, in transportation and industry.

O₃: Ozone is a form of oxygen produced when an electric spark or ultraviolet light passes through air; when near the earth's surface, it is a harmful irritant and pollutant. It plays a big part in the creation of smog.

Pb: Lead is a naturally occurring metal found throughout the environment. Lead comes from leaded automobile gasoline and emissions from smelters and refineries, for example.

PM: Particulate matter are fine particles emitted from a running vehicle, for example.

SO₂: Sulphur dioxide is a colourless gas with a strong odour, mostly comes from oil and gas processing, the burning of coal and heavy oil, pulp and paper mills, copper smelters and other metallurgical industries.

VOCs: Volatile organic compounds are released from running vehicles and power plants.

PROCEDURE

Part 1 (Introduction)

Topic Intro - Brainstorming, Connecting ideas (assess students' knowledge!) ~5-10 min.

Ask students:

Can you name some air pollutants? (e.g., CO, CO₂, NO_x, O₃, Pb, PM, SO₂, and VOCs)

Where do these pollutants come from? (e.g., automobiles, industrial power plants)

What are the effects of air pollutants? (e.g., contaminated crops & livestock, brain damage, heart damage, dead aquatic life, less oxygen in the blood, global warming, lung damage, eye irritation, damaged forests, reduced alertness, smog)

Part 2 (Setup)

Activity ~ 5 min.

Distribute the game boards, playing pieces, and the dice. Explain the rules of the game to the students (see Appendix 2 for game rules and introduction).

Part 3 (Playing the Game)

Activity ~ 10-15 min.

Students will play the Clean Air Game. The team with the lowest score (cleanest air) wins the game. Celebrate by rewarding the team with the cleanest air with applause or, for fun, a jar of clean air!

Part 4a (Discussion)

Activity ~ 5-10 min.

Based on the information presented in the Clean Air Game, ask students to assess the impact of technological change on the ecosystem.

First, ask students: "Based on the Clean Air Game, what are some technologies that lead to air pollution?" (i.e., diesel engines, cars, electric power plants, toxic cleaning solvents, metal refineries, wood stoves, and dry cleaners).

Second, ask students: "What are some of the air pollutants created by the technologies listed in the Clean Air Game?" (i.e., PM, SO₂, O₃, NO_x, VOC, Pb, HAPs, CO).

Third, ask students: “What are the effects of the pollutants listed in the Clean Air Game?” (i.e., environmental effects include contaminated crops, dead aquatic life, global warming, contaminated livestock, damaged forests, and smog; health effects include headache, cancer, breathing difficulties, brain damage, heart damage, less oxygen in blood, lung damage, eye irritation, and reduced alertness).

Part 4b (Short Discussion Paper)

Activity ~ 35 min.

Ask students to write a short discussion paper (approximately 500 words, or 2 to 3 pages double-spaced) based on the following discussion questions:

- 1) Based on the Clean Air Game, what are some technologies that lead to air pollution?
- 2) What are some of the air pollutants created by the technologies listed in the Clean Air Game?
- 3) What are the effects of the pollutants listed in the Clean Air Game?
- 4) Based on the Clean Air Game, list one solution that could help reduce air pollution. Explain how your solution would impact the ecosystem.

For more information about Windsor’s anti-idling campaign, please visit www.idlefreewindsor.org or call 519-973-1156. (After May 1, 2007, please call the Citizens Environment Alliance at 519-973-1116.)

The Clean Air Game

PARTICULATE MATTER (PM)

Your family reduces their energy use.
BREATHE THE FRESH AIR AND TAKE ANOTHER TURN.



dry cleaners

CARBON MONOXIDE (CO)



woodburning stove

GREEN SPACE

Start here
You may remove any one pollutant.

You are careful not to let your car idle for very long.
Remove one CO, PM and VOC from your atmosphere.

Your woodburning stove gives off CO, PM and Toxics.
Add one of each to your atmosphere.

Regional wind patterns carry pollutants long distances.
Take one pollutant from each category and add it to your atmosphere.

You buy a new car that uses an alternative fuel or is a low emissions vehicle.
Remove one O₂ and PM from your atmosphere.

You live near a metal refinery or have found lead paint and pipes in your home.
Add one Pb to your atmosphere.

LEAD (Pb) and HAZARDOUS AIR POLLUTANTS (HAPs or TOXICS)

Your sink cabinet and garage contain toxic cleaning solvents and other poisons which increase your risk of cancer.
Lose one turn.

SOIL CLEANING SOLVENTS

You regularly have your car tuned up.
Remove one NOx and O₂ from your atmosphere.

Your local power plant burns coal.
Add one NOx to your atmosphere.

NITROGEN OXIDES and VOLATILE ORGANIC COMPOUNDS (NOx and VOC)

The Clean Air Act passes.
BREATHE THE FRESH AIR AND TAKE ANOTHER TURN.

You can't exercise today because high ozone levels make it difficult to breathe.
Lose one turn.

RESPIRATORY PROBLEMS

GREEN SPACE

Start here
You may remove any one pollutant.

You ride your bike to work each day instead of driving.
Remove one ozone from your atmosphere.

Every member of your family commutes to work alone each day.
Add one ozone to your atmosphere.

OZONE (O₃)

You voice your concerns to your legislators.
Every player may remove one pollutant from their atmosphere.

To reduce acid rain, your local power plant switches to low sulfur coal or oil and installs scrubbers to remove SO₂ from your smokestream.
Remove one SO₂ from your atmosphere.

You have a coal-burning furnace.
Add one SO₂ to your atmosphere.

Volcanoes, pollen, forest fires and trees add natural pollutants to the atmosphere.
Lose one turn.

SULFUR DIOXIDE (SO₂)

You burn small, hot fires with seasoned wood in your woodstove.
Remove one PM and Toxic from your atmosphere.

Volcanoes, forest fires

contaminated crops

brain damage

gasoline use

damaged forests

rubbed solvents

eye irritation

contaminated livestock

lung damage

global warming

less oxygen in blood

dead aquatic life

heart damage

1. Start on a Green Space.

2. Take turns rolling die and moving game pieces. Read aloud and follow instructions on each space you land on. If you land on a pollutant space, add one of that pollutant to your score.

3. Record scores on a tally sheet.

4. The team or player with the lowest score (cleanest air) wins.

Appendix 2

Source: Avalone-King, D. (Fall 2000). "The Clean Air Game: A quick introduction to air pollution – its sources, impacts, and solutions." *Green Teacher*, 63, pp. 23-25.

(Deborah Avalone-King is an environmental educator with the Maine Department of Environmental Protection in Augusta, providing air quality resources and services to the educational community.)

When asked what are the essential factors for life, we usually answer food, water and shelter. Why do we forget about the air we breathe – that vital force that keeps us alive? We know the atmosphere exists, but we do not truly appreciate the essential role that it plays in the Earth's processes, from aerobic respiration in living things to the continuous cycling of elements such as water, carbon and minerals. Because human activities continue to disrupt the chemical balance of the atmosphere, there is a growing need to build a greater awareness of how to protect this precious resource.

The Earthminders' Clean Air Game is a great way to introduce a unit on air quality and to initiate a discussion of the importance of protecting the atmosphere. The objectives of the game are to acquaint students with sources and types of air pollutants, with the impact of air pollution on the health of people and the environment, and with actions individuals can take to prevent air pollution. The game can be used in a number of ways: in studies of energy use, it will spark discussion of how the choices we make create or ameliorate environmental problems; in ecology, it will highlight how non-living aspects of the environment change in response to human and other factors; and in science and technology, the game can be part of a unit on assessing the environmental impacts of technology and developing a personal sense of global stewardship. Regardless of where the Clean Air Game fits into your curriculum, it is a fun way to increase your students' awareness of the importance of protecting a resource that is vital to all of the Earth's systems.

Playing the Clean Air Game

The Clean Air Game can be played by students of all ages, from elementary school to high school. The suggested play time is 20 to 30 minutes for younger students and 10 to 15 minutes for older students. Additional time is needed for processing and sharing what is learned.

To play the game, students form teams of four or five. Each student has a playing piece and each team has a die. Players start on one of the two Green Spaces and move clockwise around the board. As players land on spaces, they read aloud the description and add or remove pollutants from their atmosphere as directed. When landing on pollutant spaces, players must add on of those pollutants to their atmosphere. (The purpose of these spaces is to familiarize students with the names and chemical abbreviations of pollutants.) Individual players may wish to keep track of their own scores, but the team score is what matters. The team with the lowest score (cleanest air) wins the game.

Scoring can be done on score sheets... For example, students may keep a general pollution score, with one column for adding pollutants and one column for removing pollutants, and sum it up at the end of the game. Or they may track each of the six pollutants on the board. As a follow-up, students may graph the results, analyse the data, and develop their own Clean Air Act with strategies for reducing each of the six types of air pollution.

Celebrate at the end of the game by rewarding the team that has the cleanest air (least points) with applause or, for fun, a jar of clean air! Have each group share examples of the actions or events that caused them to have dirtier air or cleaner air. This reflection is an important way to process the information and better relate the activity to their own lives and the actions they can take to reduce pollution.

The Clean Air Game was developed by Maine teacher Page Keeley from an activity in the *Environmental Resource Guide – Air Quality*, a curriculum resource for use in grades 6 to 8, produced by the Air and Waste Management Association. The guide is available in English, French or Spanish for US\$33.50 plus s&h from A&WMA, (800) 275-5851 or (412) 741-1288.

ASSESSMENT TOOL

The Sustainability of Ecosystems: The Clean Air Game

Teacher Name: _____

Student Name: _____

CATEGORY	4	3	2	1
Knowledge/ Understanding (Understanding of relationships between concepts gained by writing a short discussion paper about the Clean Air Game)	Demonstrates a thorough and insightful understanding of relationships between concepts (e.g., reducing the time you spend idling your car can prevent CO, PM, and VOC from entering your atmosphere, or by keeping your diesel truck's engine properly maintained, you can avoid putting PM and HAPs in your atmosphere).	Demonstrates a considerable understanding of relationships between concepts.	Demonstrates some understanding of relationships between concepts.	Demonstrates a limited understanding of relationships between concepts.
Communication (Communication of the information and ideas presented in the Clean Air Game via a short discussion paper)	Communicates information and ideas with a high degree of clarity and precision (e.g., explaining with clarity how air pollution can affect the ecosystem).	Communicates information and ideas with considerable clarity and precision.	Communicates information and ideas with moderate clarity and precision.	Communicates information and ideas with limited clarity and precision.
Making Connections (Assessment of impacts of technology on the environment as presented in a short discussion paper)	Assesses environmental impacts with a high degree of effectiveness (e.g., listing how air pollution affects aquatic life, crops, forests, livestock, and the human body – mentioning that air pollution causes smog and global warming).	Assesses environmental impacts with considerable effectiveness.	Assesses environmental impacts with moderate effectiveness.	Assesses environmental impacts with limited effectiveness.