

Sharing the Air

Abstract

Students learn how countries play an active role in developing health and environment policies to reduce air pollution. Students work in groups representing different countries. They discuss various topics surrounding air pollution with respect to their country and then share their conclusions with the class.

Logistics

Time Required

- **Class Time:** Part A 15 minutes / Part B 55 minutes
- **Prep Time:** 15 minutes

Materials

PART A

- “Sharing the Air Images,” one image per student

PART B

- “Sharing the Air: Jigsaw Table Student Worksheet,” one per student
- “Sharing the Air: Being a Country – Thinking like the World Student Worksheet,” one per student, and “Teacher Answer Key”
- “Sharing the Air: Theme Data Cards,” one set per country group, and “Teacher Answer Key”

Learning Objectives

- Recognize that air pollution is a global problem and gain awareness of the differences among countries in air pollution and respiratory health.
- Discover how laws, education, population and economics support or reduce a country’s ability to respond to reducing air pollution.
- Recognize the important leadership role that Canada and other western countries play in supporting third world countries in reducing air pollution.
- Recognize that many third world countries are industrializing like western countries and the need for supports/incentives to reduce air pollution.

Prescribed Learning Outcomes BC Curriculum:

Weather and Climate

- D6 Explain how climate affects human activity
- D7 Analyze interactions between human activity and the atmosphere, with reference to global climate change

Preparation

1. Read through the classroom implementation steps to get an overview of the lesson plan.
2. Photocopy the required materials as needed.

Classroom Implementation

Part A: Pollution – Far and Wide

Students examine an image relating to air quality and construct questions based on what they observe.

1. Distribute one of the four “Sharing the Air Images” to each student.
2. Ask students to study their image and take one minute to reflect on how they feel the image relates to air quality.
3. Ask students to find another person in the room with the same image and share their ideas.
4. After three minutes, ask students to join another pair and briefly share their top three ideas with the other pair.
5. Ask the groups to come up with a list of questions that the image generated about pollution and solutions and then add them to a class list on the board or piece of flipchart paper for revisiting.

Part B: Air Pollution – Jigsaw

Students examine country profiles and construct connections between health, economy and the environment. .

1. Divide the students in to diverse country groups of five. Identify a student to act as the group leader for each country. Ask another to act as timekeeper for the group, and a third as a gatekeeper to ensure that everyone in the group has an opportunity to speak. Assign a country to each of the groups (it is fine if there are duplicates).
2. Distribute the — Sharing the Air: Jigsaw Table Worksheet to each student. Distribute a set of —Sharing the Air: Theme Cards to each country group. Have one person in each group take one of the five Sharing the Air: Theme Data Cards. Explain that each student in the group will be their country’s Expert for the theme they received.

3. Allow five minutes for country teams to familiarize themselves with the overall task: to better understand the connections between asthma, health, the economy and the environment, and the needs and roles of different countries in addressing these challenges.
4. Inform students that they will now find and work with the other students who are acting Experts on a particular theme. They will need their —Jigsaw Table Student Worksheet and —Theme Data Cards to complete this. Ask students to group themselves with other students with the same theme (A through E).
5. Give students 15 minutes to discuss and answer the three questions on their—Theme Data Card and to transfer the key points from their theme onto the —Jigsaw Table Student Worksheet.
6. When most groups look ready, ask students to return to their original country groups and inform them that their group has two tasks to complete in 20 minutes. Provide a countdown every five minutes to ensure the groups complete all questions.
 - a. The first task is for each Expert on the team to share their perspective and most key information from their theme. Each student in the country group is to transfer this information to their —Jigsaw Table Student Worksheet.
 - b. The second task is to answer the questions on the Being a Country — Thinking Like the World Worksheet together. Distribute one worksheet per student to each group.
7. Circulate around the room to provide support and observe.
8. Bring the class back together as a whole. Ask one person from each country group to share how their thinking on their particular theme has changed after hearing the ideas from the rest of their group (Question 1 on the worksheet).
9. Debrief with students about how they felt about the impact of air pollution in other countries. Read the following statement from their worksheet and inquire about their country team discussions on this quote: *More than half of the burden of air pollution on human health is borne by people in developing countries.*
10. Continue the class discussion with students using the questions from their “Being a Country – Thinking Like the World Worksheet” as a guide. Explore questions like the following with students:
 - a. *As one of the world’s most healthy and wealthy countries, what are your thoughts on Canada’s obligation to other world nations?*
 - b. *How can Canada show leadership in helping reduce air pollution in other countries? Are their direct and indirect ways for Canada to help and lead the way for developing countries?*
 - c. *How can expertise from developed countries such as Germany, the United*

Kingdom and the United States support Canada in addressing our own challenges more effectively?

d. *What other questions or ideas do you have from the jigsaw activity?*

Extension

1. **COMPARING COUNTRIES** - Ask students to select a country other than Canada from their “Theme Data Cards.” Ask them to create a story about someone travelling from that country to Canada. Students may choose whether they have asthma or are healthy. Using the “Theme Data Cards” and what they learned about the different challenges and benefits between countries, have students tell a story about how life in the two countries would be different. They can use the information from the “Jigsaw Table Student Worksheet” or “Being a Country – Thinking Like the World Worksheet” to compare Canada and the other country.
2. **MIND MAP** - Ask students to work in groups to create a mind map that compares the strengths and challenges between two countries and suggest solutions to challenges. Ask the groups to share their thoughts.
3. **INDOOR AIR QUALITY ISSUES** - Students can research indoor air quality to learn ways to ensure that the places where they spend time indoors have good air quality. There are many indoor air quality topics that students could research such as asbestos, tobacco smoke, carbon monoxide, moisture and mould, chemical contaminants and lead. Canada is one of the world’s largest asbestos producers and exporters – more than 95% of what Canada produces is exported. Asbestos is classified as hazardous to health and is under restricted use in Canada.
4. **GET ACTIVE** - Illustrate issues related to air pollution and the impact of poor air quality. Divide the class into two groups with one group called CLEAN AIR and the other group called AIR POLLUTION. Mark out a rectangular playing area with a start area on one end and a finish area on the other end (if using the gym, use the whole gym). The center is the pollution zone. The CLEAN AIR team will line up in the start area, and their goal is to run across the pollution zone to the finish zone. The AIR POLLUTION team will need soft-foam balls, and their goal is to tag members of the CLEAN AIR team as they cross through the pollution zone with the soft-foam balls. If a CLEAN AIR player is hit with a ball, they return to the start area and sit down. Once all of the players are either sitting in the start zone or have entered the finish zone, the game is over. You can switch players on the two teams and increase or decrease the number of Air Pollution team members to illustrate better or poorer air quality days.
5. **CLEAN AIR CHAMPIONS** - Refer to the Clean Air Champions website for other quizzes, activities and games:
http://www.cleanairchampions.ca/programs/air_aware/quizzes_activities_and_games.php

SHARING THE AIR - **Images**

One image per student is required.

IMAGE 1



IMAGE 2








IMAGE 3



IMAGE 4



SHARING THE AIR – Jigsaw Table Student Worksheet

COUNTRY	Canada	China	Europe (Germany and UK)*	India	United States
Population size; Density (people/km²); Main languages	~ 34,500,000 3.8 English/ French	~1,340,000,000 140.4 Mandarin/ Cantonese	~72,000,000 246.9 English/ German	~1,205,000,000 405.3 Hindi/ English	~314,000,000 34.3 English/ Spanish+
Map					
Health levels (Asthma)					
Urban Air Quality					
Power Generation					
Wealth and Standard of Living					
Air Pollution Facts & Indices					

**Europe = Average of Germany and UK population and density only*

SHARING THE AIR – **Being a Country – Thinking Like the World** **Student Worksheet**

In your country group, answer the following questions using your collective knowledge as experts in each of the five theme areas.

1. How has your thinking on your own particular theme (A, B, C, D, and E) changed after hearing the ideas from the rest of your group?
2. How do you feel about the impacts of air pollution in countries outside of Canada, based on your country team data and shared information?
3. What do you feel is Canada's role in addressing air pollution in other countries?
4. What assistance or support can other countries provide to Canada?
5. What other questions or ideas do you have from the jigsaw activity?
6. How has your thinking on air pollution changed as a result of the jigsaw activity?

Theme Data Cards

A. HEALTH LEVELS (ASTHMA AND ALLERGIES)

Indoor and outdoor air pollution plays a big role in world health. More than half of the world's population relies on wood, dung, crop waste, or coal to meet basic energy needs. Burning these materials on open fires and stoves without chimneys creates indoor air pollution. Exposure to air pollution is the main threat to human health in many urban areas. Being exposed to high levels of soot and particulates contributes to many health problems, including asthma, lung cancer, heart disease and premature death.

	Canada	China	Europe*	India	United States
Average Healthy Life** (years)	Male 70 Female 74	Male 63 Female 65	Male 70 Female 73	Male 53 Female 54	Male 70 Female 74
Death rates per 100,000 asthma patients	1.6	36.7	1.9	unavailable	5.2

*Europe = Average of Germany and UK values.

** Average Healthy Life = "Healthy Life Expectancy" – the number of years on average that individuals will live healthy lives in this country.

ASTHMA AND AIR POLLUTION FACTS

- Asthma is the second leading cause of adult death and disability worldwide, with 180,000 preventable deaths each year.
- The rate of death of asthma patients is highest in China, and asthma levels in that country are rising. Doctors often are not trained to diagnose or treat the condition properly.
- Asthma, which is often caused and aggravated by air pollution, affects more than 3 million Canadians and more than 300 million people worldwide.
- In 2008, the costs related to air pollution topped \$8 billion. By 2031, these costs are expected to grow to more than \$250 billion.
- More than 80% of people with asthma also suffer from allergic rhinitis (often referred to as hay fever causing inflammation of the nose as well as red, itchy, watery eyes).

QUESTIONS

1. What do you notice about the average life span and number of deaths from asthma in different countries in the world?
2. What do you think might be some of the causes of the differences between countries that you see?
3. For the countries with more deaths from asthma, what three things can you suggest to help?

Theme Data Cards

B. URBAN AIR QUALITY

Particulate pollution causes a lot of health problems around the world. Particulate Matter (PM) is very small pieces of matter in the air. The smaller they are, the more harmful they are. In many developing countries, families heat their homes and cook food using wood or coal on simple stoves or over open fires. These methods create a lot of smoke and PM. The indoor air pollution caused by open stoves leads to more than 1.6 million deaths each year.

Two chemicals that come from burning fuel for cars, trucks and factories—sulfur dioxide (SO₂) and nitrogen oxides (NO_x)— create acid rain. Acid rain changes soil by removing important minerals and nutrients. Plants and trees growing in the soil are harmed by acid rain.

Annual Air Quality Comparison of Countries

	Canada	China	Europe*	India	United States
Particulate Matter (PM, 10) 2004	18	140	20	79	27
SO₂ - Sulphur dioxide, 2001	14	111	16	23	15
NO₂ – Nitrogen dioxide, 2000	41	71	49	22	52

*Europe's values are averages of Germany and United Kingdom. Units = $\mu\text{g}/\text{m}^3$

ASTHMA ALLERGIES AND AIR POLLUTION FACTS

- In 2007, for the first time, more people in the world lived in cities than rural areas, due to large migration in China from rural areas to cities.
- Concentrations of allergens such as pollen are also increased from air pollution. This impacts people with seasonal allergies as well as those with seasonal allergies and asthma.
- Vehicle emissions are responsible for 70% of India's air pollution. In the past 20 years, exhaust from vehicles has increased eight times. Bangalore is the asthma capital of India.
- Air pollution is thought to be the main cause of China's 40% rise in asthma rates over the last five years. From 1990 to 2000, asthma rates in children living in cities rose by 64%.
- A United State's study (2002) estimated that 30% of childhood asthma is due to environmental exposures, costing that nation \$2 billion per year.

QUESTIONS

1. *What do you notice about health and activity levels in different countries in the world?*
2. *What do you think might be some of the causes of the differences you see?*
3. *For countries with low levels of air quality, suggest three things that would help raise air quality levels.*

Theme Data Cards

C. POWER GENERATION

Most coal that is burned as fuel causes high levels of air pollution in the form of Particulate Matter (PM). PM is very small pieces of solid matter—like dust—in the air. Coal is still one of the main forms of fuel used for power, industry and home heating around the world.

Fossil fuels produced (for use inside countries or export) (in Mt = Megatonnes)	Canada	China	Europe*	India	United States
Crude Oil Production	155	190	3/70	35	300**
Coal Production	70	2760	50/20	490	1,000
Electricity produced from Renewable source (in GWh = Gigawatt hours)	Canada	China	Europe*	India	United States
Solar	26	120	1,500	20	689
Hydro	370,000	485,000	63,000	124,000	275,000
Wind	3,024	8,800	16,600	12,000	34,600
Biomass/ Biofuel	8,300	2,300	13,500	1,900	49,500

*Europe values average Germany and UK or both. **Only Saudi Arabia (509Mt) and Russian Federation (485Mt) produce more oil than USA.

ENERGY AND AIR POLLUTION FACTS

- Each week, the equivalent of three new coal-powered energy production plants are built in China.
- There is great potential for electricity from wind and solar power around the world. Today, 20% of Denmark's electricity come from wind power. Wind and solar power sources create 50 to 100 times less emissions than coal-fired or oil-fired power plants to create the same amount of energy.
- The amount of biomass power in Europe could double from 2010 to 2030, but it must be developed carefully to avoid other environmental impacts.
- Sweden plans to be the first country in the world to be fossil fuel free—by 2020.
- In 2006, coal was used to produce 74% of the electricity used in Alberta, 63% in Saskatchewan, 60% in Nova Scotia and 18% in Ontario.

QUESTIONS

1. *How do oil and coal production and renewable electricity differ among countries?*
2. *What do you think might be some of the causes of the differences you see?*
3. *What might countries with less renewable power electricity (relative to their size) do to increase their use of renewable energy sources? How might leading countries help?*

Theme Data Cards

D. WEALTH AND STANDARD OF LIVING

Gross Domestic Profit, or GDP, is one way economists measure the wealth of countries and the people living in them. GDP has been used for a long time to measure how much a country's wealth is growing or shrinking. Some economists point out that one big problem with GDP is that it does not look at negative factors like rising air pollution when a country is growing. These economists say that we should count air pollution and other environmental harm as something that shrinks wealth, because it harms people's health and the health of the environment they depend on.

These economists suggest that we begin using a new measure of wealth and well being that includes environmental factors. Some economists are using the Genuine Progress Indicator, or GPI. GPI includes people's well being, which includes factors like levels of air pollution. The GPI is being used by a number of cities in Canada. The World Bank just launched the Global Partnership for Wealth Accounting and Ecosystem Services (WAVES) to help better value ecosystem services to reduce ecosystem degradation and biodiversity loss. Another measure, Gross National Income—shown in the table below—allows us to compare the buying power of people in different countries.

	Canada	China	EU	India	United States
Average Income	\$36,300	\$4,700	\$34,400	\$2,500	\$44,100

*Measured as Gross National Income per capita (PPP international = Purchasing Power Parity which is a way to show the buying power of citizens in different parts of the world).

AIR POLLUTION AND ECONOMIC FACTS

- A study in British Columbia in 2005 showed that if we reduce particulates and ground level ozone by 1%, we could save \$29 million in health care costs each year.
- The World Health Organization estimates that 30 minutes of physical activity each day will decrease the amount of cardiovascular disease by 50%.

QUESTIONS

1. *What do you notice about the levels of people's wealth in different countries in the world?*
2. *What do you think might be some of the causes of the differences you see between countries?*
3. *How might people in countries with high average income contribute more to air quality problems? How do you think this differs for people in low-income countries?*

Theme Data Cards

E. AIR POLLUTION ACTS AND INDICES

Countries try to address air pollution in many ways. They monitor air pollution levels and provide the public with information about air quality using tools such as indices. Canada is the first country in the world to use the Air Quality Health Index, or AQHI. Countries also set up policies and laws (Acts) that support government, industry and individuals in making choices that reduce pollution. They set rules and limits on acceptable levels of pollution, and they punish polluters.

	Canada	China	EU	India	United States
Acts	There are Canada Wide Standards (CWS).and National Ambient Air Quality Objectives (NAAQOs). CWSs are intended to be achievable targets – PM and ground-level ozone are priorities.	The State Environment Protection Agency enacted Air Pollution law in the 1990s, and China is now expanding it. Coal-powered energy plants are a large challenge.	National Emissions Ceiling has set some regulations. The UK has set specific targets, monitors, and has city-level responsibility. Transportation is the largest air pollution challenge.	The Air (Prevention and Control of Pollution) Act was passed in 1981. Poor fuel standards and quick transportation growth is challenging India.	US Congress Clean Air Acts from the 1960s to the 1990s served as a guide for the European Union. Targets, reporting and enforcement are in place.
Index	AQHI provides regional air quality information to support good lifestyle choices, but not all provinces are using it.	Mainland China has an Air Pollution Index (API) and monitoring programs as of 2008.	The UK created a daily warning system on air pollution levels to help people with respiratory and heart disease.	One index (IND-AQI) has started, providing online access to regional air quality information.	The Air Quality Index (AQI) monitors air pollutants and makes data available nationally and regionally.

AIR POLLUTION POLICY AND LAW FACTS

- In China, the government guarantees free winter heating in the North, but inefficient coal-powered boilers create high levels of air pollution from particulates.
- Air pollution causes 400,000 deaths in China every year. One third of the air pollution over the cities of San Francisco and Los Angeles in the United States comes from Asia.
- The GAINS program Clean Air Scorecard helps developing countries reduce air pollution.

QUESTIONS

1. *What are the similarities and differences between the countries Air Pollution Acts?*
2. *How does Canada’s AQHI compare with that of the other countries?*
3. *How do you think different laws, measures or events can help citizens and government change their behaviour on air pollution?*

SHARING THE AIR – **Teacher Answer Key Jigsaw Themes**

Suggested responses and teacher notes (using **Urban Air Quality** as an example).

1. What do you notice about health and activity levels in different countries in the world?

The first question in each —Theme Data Card— supports students exploring some of the trends in the cards. Conditions are generally more polluted, impoverished and unhealthy in developing countries. The questions vary for each theme area, and they are all intended to evoke a wide range of participation from students without implying any one correct answer. By sharing out loud in their Expert groups, students may begin to observe patterns. Student leaders for each group will need help in facilitating conversation on the questions. You may help by visiting groups as they work through these open-ended questions, helping draw out students so the group can capture information and their perspectives and/or conclusions.

2. What do you think might be some of the causes of the differences you see?

For all Expert groups, this kind of question is intended to invite deeper thought—connecting the facts in question 1 to their possible causes. It is important for students to see that facts presented side-by-side do not necessarily prove causation. In the case of extreme elevations of air pollution, associated health and cost impacts are increasingly real. While asthma can be triggered by multiple factors and partially linked to genetics, the alarming rates of recent growth, particularly in children in developing countries, appears to be linked to the parallel growth of air pollution and to poor diagnosis and treatment opportunities.

The level of sophistication in thinking will likely be higher in older students. Younger students may benefit from teachers suggesting categories of causes (e.g., the timing of industrial development). Some themes will lend themselves more directly to discussions on air pollution.

3. For countries with more low levels of air quality, suggest three things that would help raise air quality levels.

This question varies by theme. For the Urban Air Quality theme, air quality can be raised through collective action (people biking and walking more and driving less) but also through government regulation and policy (clean fuels, incentives to not use cars, bicycle pathways and other infrastructure, high taxes and fines on heavy polluters, incentives to industry that reduce air pollution levels) and industry initiatives (leading by example, forming coalitions to support change, supporting industry standards).

Students will learn solutions particular to their theme, and in the discussion afterward, you can help them begin to identify categories of available solutions (e.g., technology, law, education, personal action, government incentives). As categories overlap and require explanation, students will begin to see how the different themes are related.

SHARING THE AIR – Teacher Answer Key Being a Country – Thinking Like the World

1. How has your thinking on your own particular theme (A to E) changed after hearing the ideas from the rest of your group?

Students may have been able to connect ideas between several themes. For example, seeing how low Canada's current investment in solar and wind power is relative to the United States, while our incomes and air pollution levels are similar, may have students wondering why our air pollution laws are not further advanced.

2. How do you feel about the impacts of air pollution in countries outside of Canada, based on your country team data and shared information?

The air pollution endured in many developing countries in Asia, Africa, and Latin America is extreme and impacts the health of the people living there. For students who have not travelled or lived overseas, seeing these values for the first time may help them realize we have a tremendous quality of living in Canada that is worth protecting.

3. What do you feel is Canada's role in addressing air pollution in other countries?

Canada can play a leadership role in providing engineering, policy, technology and labour/training for people in developing countries. Several European countries including Germany have done so in the past. Canada can also set high standards for itself. As a wealthy nation rich in resources, Canada could become a world leader in clean and alternative sources of energy and in promoting healthy living.

4. What assistance or support can other countries provide to Canada?

The United States and several European Union countries such as Germany and the United Kingdom have superior infrastructure, policies and government programs that support pollution reductions, technology innovations, investment in renewable energy, and transportation alternatives. We can learn from these countries. Canada can also learn about active lifestyle promotion from European countries that rely much more than we do on cycling, walking and other modes of transportation.

5. What other questions or ideas do you have from the jigsaw activity?

Will vary with student responses.

6. How has your thinking on air pollution changed as a result of the jigsaw activity?

Students may be better able to appreciate some of the challenges faced by people in other countries, our good fortunes in Canada and our global responsibility to support advancement in other countries while we model best practices at home.

ACKNOWLEDGEMENTS AND SOURCES

JIGSAW ACTIVITY

<http://www.jigsaw.org/steps.htm>

POPULATION DENSITY

http://en.wikipedia.org/wiki/List_of_countries_by_population_density

THEME DATA CARDS

Health Levels (Asthma) Theme

World Health Organization, <http://www.who.int/countries/can/en/>

World Bank, http://siteresources.worldbank.org/DATASTATISTICS/Resources/table3_13.pdf

International Energy Association (IEA) <http://www.iea.org/stats/prodresult.asp?PRODUCT=Oil>

Asthma Death Rates,

http://ec.europa.eu/health/major_chronic_diseases/diseases/asthma/index_en.htm

<http://www.ginasthma.org/reports-global-burden-of-asthma.html>

Air Pollution Costs, http://en.wikipedia.org/wiki/Air_pollution_-_Canada

URBAN AIR QUALITY THEME

WorldBank, http://siteresources.worldbank.org/DATASTATISTICS/Resources/table3_13.pdf

Harvard Magazine, <http://harvardmagazine.com/2008/09/greening-china-market-solutions>

World Health Organization, <http://www.who.int>

Medical Impacts, <http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2806%2969267-2/>

POWER GENERATION THEME

Key World Energy Statistics, 2009, <http://www.iea.org/media/weowebiste/2009/WEO2009.pdf>

IEA 2007 Country Database, <http://www.iea.org/stats/index.asp>

WEALTH & STANDARD OF LIVING THEME

Genuine Progress Indicators, <http://www.pembina.org/economics/gpi> and

http://en.wikipedia.org/wiki/Genuine_progress_indicator

BC Study on air pollution and savings,

http://www.bc.lung.ca/pdf/health_and_air_quality_2005.pdf

AIR POLLUTION ACTS AND INDICES THEME

Canada Wide Standard (CWS), http://en.wikipedia.org/wiki/Air_pollution

India, <http://home.iitk.ac.in/~mukesh/air-quality/BASIS.html>

<http://www.gits4u.com/envo/envo4.htm#Air%20Pollution>

China, <http://www.cleanairnet.org/caiasia/1412/article-70231.html>

Clean Air Scorecard, <http://cleanairinitiative.org/portal/node/4172>

GAINS, <http://gains.iiasa.ac.at/index.php/gains-asia>

http://web.mit.edu/cepr/www/publications/reprints/Reprint_219_WC.pdf

China's Green Revolution, <http://www.popsci.com/scitech/article/2007-07/chinas-green-evolution?page=7>

China's SEPA website in English, <http://english.sepa.gov.cn/>

United States, <http://nrdc.org/health/effects/fasthma.asp>