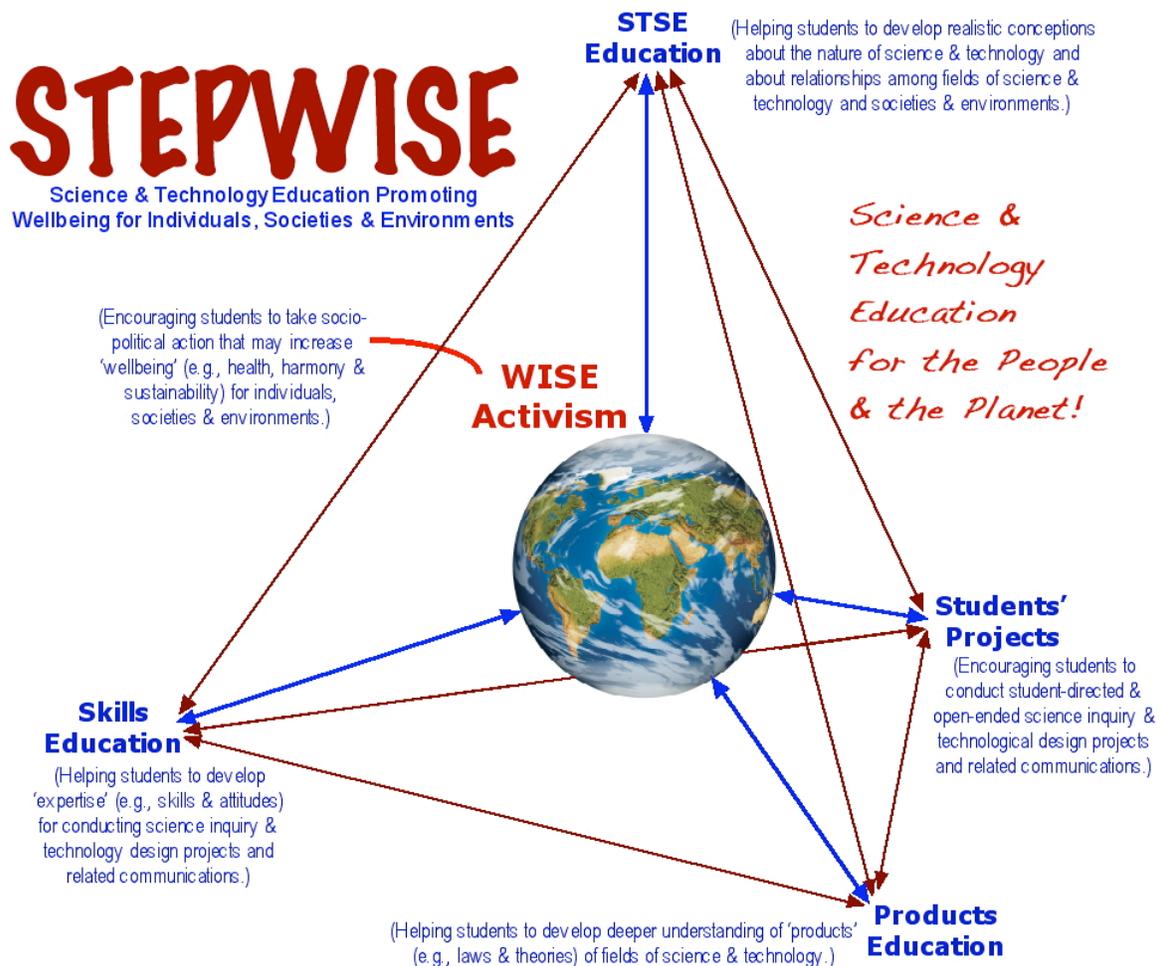


STEPWISE

<http://www.stepwiser.ca>

CARS & THE ENVIRONMENT Case Method

The case method provided here is based on the STEPWISE curriculum and instructional framework provided below. This and other case methods provide some basic information about a 'WISE' issue, such as possible problems relating to cars. Teachers then provide instruction in each of the STEPWISE elements, and encourage students to conduct research to enhance their knowledge, skills and findings (in the case of Students' Projects) — related to the STEPWISE framework. Instruction and student work culminate in students' WISE Activism; i.e., action(s) to address the WISE issue.



ACKNOWLEDGEMENTS

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STEPWISE Case Method

IMPACT OF CARS ON THE ENVIRONMENT

Introduction

Cars have revolutionized transportation. But more than simply providing transport, the car is a symbol of status, wealth and luxury. In fact for many people the acquisition of a personal vehicle is a major life goal. However in recent times, the health and environmental impacts associated with the production, use and disposal of cars have been highlighted. In response to mounting scientific evidence and increasing public awareness, automobile companies have developed a number of alternative technologies that they commonly advertise as “greener” (environmentally friendly). Students should be urged to use their scientific expertise to critically assess “greener” car technologies and also other alternatives for addressing the negative impact of cars on society.

WISE Issue	Resources/Factors in Decision-making			WISE Action
	STSE Expertise	Products Expertise	Activism Expertise	Possible Action Projects
Impact of Cars on the Environment	Environmental and health impacts associated with the production, use and disposal of cars	<p>Function of the internal combustion engine</p> <p>Effects of pollutants in car exhaust</p> <p>Alternative technologies to the internal combustion engine</p>	<p>Assessing the benefits and hazards of a specific technology</p> <p>Developing and carrying out an action plan</p>	<p>Education campaign e.g. informational brochure or ad</p> <p>Community change campaign e.g. organizing a “car free day” in the school community</p> <p>Personal lifestyle change e.g. walking,</p>

	NoST Expertise Opportunities to explore: the economic and cultural factors that can influence science and technology	Skills Expertise Expertise for: hypothesizing, experimenting, developing prudent conclusions	Project(s) Findings Results and conclusions from experimental studies on vehicular emissions	using bicycles when possible
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Previous Knowledge

Students should be able to describe the combustion of an organic compound

Curriculum Expectations Addressed

This case is appropriate for the following grades and strands:

Grade	Course	Strand	Specific Expectations Addressed
7	Science and Technology	Earth and Space Systems: Heat in the Environment	HE1.01 describe causes and implications of global warming and analyze personal choices with respect to production of greenhouse gases.
9	SNC 1D, SNC 1P	Biology: Sustainable Ecosystems	SE2.3 describe the importance of photosynthesis and cellular respiration as complementary processes in an ecosystem (e.g., plants use carbon dioxide to perform photosynthesis and this is a by-product of cellular respiration) and explain how humans can affect these processes (e.g., humans increase the production of CO ₂ in the environment through automobile exhaust, humans plant more trees to eliminate CO ₂ in an environment).
12	SNC 4M	Energy Alternatives and Global Impact	EA1.1 apply energy-related concepts (e.g., efficiency, thermal pollution, local availability of resource) to evaluate the environmental impact of alternative and conventional energy sources and propose an "environmentally-friendly" solution to reduce non-renewable energy consumption (e.g., hybrid cars, solar panels).

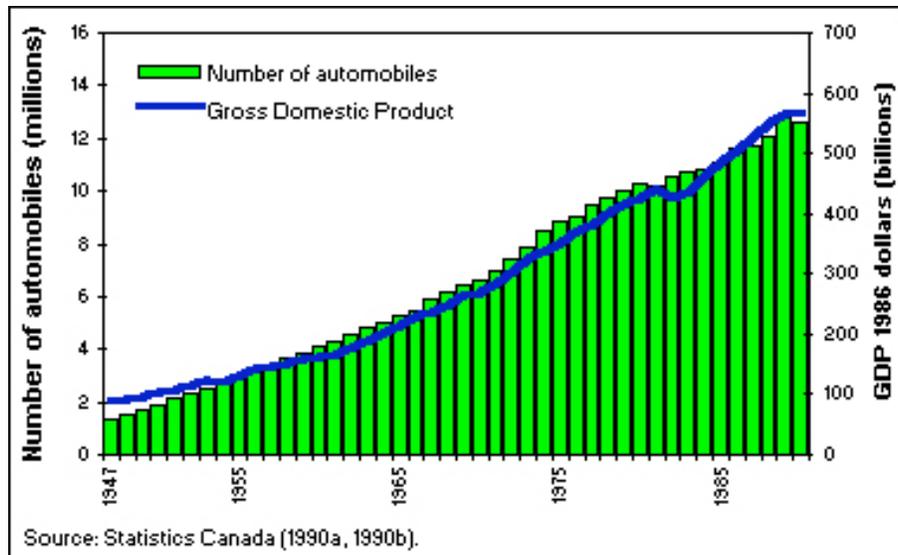
Information Sheet #1

Some Statistics about Cars

“The typical American male devotes more than 1,600 hours a year to his car. He sits in it while it goes and while it stands idling. He parks it and searches for it. He earns the money to put down on it and to meet the monthly installments. He works to pay for petrol, tolls, insurance, taxes and tickets. He spends four of his sixteen waking hours on the road or gathering resources for it. And this figure does not take account of the time consumed by other activities dictated by transport: time spent in hospitals, traffic courts and garages: time spent watching automobile commercials or attending consumer education meetings to improve quality of the next buy. The model American puts in 1,600 hours to get 7,500 miles: less than five miles an hour.”

(Ivan Ilich, *Energy and Equity*, (1974))

- In **2000** there were nearly **700 million** Light-duty road vehicles (automobiles, and light trucks) operating around the world.
- According to a recent forecast by the United Nations, the number of cars and commercial vehicles, will rise to **1,6 billion** by the year **2030**.
- Light-duty vehicles are the principal providers of **personal mobility** today throughout most of the developed world. The automobile dominates passenger travel: at least **75%** of distance traveled is by car, except in **Japan** (63%) and **Spain** (69%).
- There are over **12 million cars** in Canada - one for nearly every two Canadians. This represents one of the highest car ownerships in the world. The graph shows the correlation between the number of automobiles and economic growth in Canada over time.



- In 1990 29 % of fossil fuel consumption in Canada was used for transportation. About half of this was directly due to automobile use.
- The automobile is one of the most inefficient forms of transport in terms of energy use per person. The table below energy use for various modes of transportation.

Transportation mode	Fuel or electricity use (L/100 km)	Number of commuters	Energy use (MJ/person-km)
Automobile	15	1	4.74
		6	0.79
	10	1	3.16
		4	0.79
	7	1	2.21
Van	20	4	0.55
		15	0.42
Diesel bus	10	7	0.45
Subway	56	40	0.52
GO Rail	2.61 kwh/km	75 (per car)	0.13
	761	810	0.35

MJ = megajoule
Source: Modified from Healthy City Office (1991).

For more statistics see:

Environment Canada- *Environmental Implications of the Automobile (SOE Fact Sheet No. 93-1)*

<http://www.ec.gc.ca/soer-ree/English/products/factsheets/93-1.cfm>

Youth XChange- Using Cars

http://www.youthxchange.net/main/b273_using_cars-a.asp

Information Sheet #2

The Environmental Impact of Cars

Cars impact the environment during their manufacture, use and disposal.

Manufacturing

Material	Weight (kg)
Plain carbon steel	643.6
High-strength steel	106.4
Stainless steel	14.1
Other steel	21.4
Iron	208.6
Plastics/composites	102.0
Fluids/lubricants	81.6
Rubber	61.1
Aluminum	70.7
Glass	38.6
Copper	22.5
Zinc	9.1
Other materials	47.5
Total	1 427.7
<small>^a Includes cars, vans, and station wagons. Source: Government of Canada (1991).</small>	

The manufacturing process uses up raw materials such as steel, iron, rubber, plastics and aluminum. It also produces large amounts of substances that deplete the ozone layer, act as greenhouse gases and use up huge quantities of energy.

Table 1

Weights and types of materials used to construct an average motor vehicle

Use

The typical car runs by using gasoline. The car engine converts the chemical energy stored in gasoline into kinetic energy to make the car move. Currently, the easiest way to do this is to burn gasoline inside the engine. A car engine is therefore **internal combustion engine**- combustion takes place internally.

Inside the engine, a spark ignites a mixture of gasoline and air. The explosive energy moves a piston (much like the plunger in a syringe) up and down. The piston is connected to a crankshaft that rotates to turn the wheels of the vehicle. However, in addition to producing a large amount of energy, the combustion of gasoline, produces a number of gases. These gases are the **exhaust** that leaves the engine through the tailpipe.

For more detailed accounts of the internal combustion engine works you can go to:

Howstuffworks - <http://auto.howstuffworks.com/engine1.htm>

Wikipedia- http://en.wikipedia.org/wiki/Internal_combustion_engine

Emission	Health Impacts	Environmental Impacts
Carbon Monoxide (CO)	Reduces the ability of the blood to carry oxygen. Can lead to CO poisoning especially in smokers, persons with heart conditions or anemia.	May contribute to the formation of ground level ozone, the main ingredient in smog.
Carbon Dioxide (CO ₂)		An important greenhouse gas that contributes to global warming

Nitrogen Oxides (NO, NO ₂)	Irritates the lungs in high concentrations May hamper the functioning of the immune system in children and elderly people	Reacts with water vapor to form acid rain Contributes to the formation of low level ozone and smog Suppresses vegetation growth
Sulphur Oxides (SO ₂ , SO ₃)	Irritates the lungs	Reacts with water to form acid rain Contributes to formation of low level ozone and smog Damages the young shoots of plants
Volatile Organic Compounds (VOC's)	Many VOC's like benzene are carcinogens or neurotoxins	Contribute to the formation of low level ozone
Ozone(O ₃)	Changes in lung function Impaired immune function Chronic lung disease	A major ingredient in smog which reduces visibility and negatively impacts all living things.

Table 2: Major impacts of common pollutants found in car exhaust

Disposal

Disposal of old cars and car components-tires, batteries and oil- further increase the environmental impact of the car.

- Over three-quarters of a million tonnes of scrap plastic were produced in 1990 just from cars in Europe.
- In 1988, 209.5 million car tires, 42.7 million truck tires and 19 million road tires were produced in the USA alone.
- Car dumps themselves cause local pollution with high concentrations of lead, cadmium and zinc.
- 100 million batteries are discarded per year. Their sulfuric acid contents represent a substantial environmental threat.
- In Western Europe, Japan and the USA nearly 40 million cars are discarded every year.

For more statistics see:

World Carfree Network <http://www.worldcarfree.net/resources/stats.php>

Information Sheet #3

Reducing the Environmental Impact of Cars

Technology Based Solutions

In response to environmentalists' and public concern automobile companies have come up with a number of innovations which modify cars to make them more "green" or environmentally friendly.

Compact or "smart" cars- are smaller and therefore supposed to be more fuel efficient.

"Hybrid" cars- use a mixture of gasoline and alternative fuel sources e.g. natural gas, biodiesel or ethanol, which are supposed to produce less polluting emissions.

Electric cars- contain an electric engine which does not run directly on fossil fuels.

Engine Improvements- Fuel injection systems have been designed to reduce greenhouse emissions in traditional gasoline and diesel cars.

Catalytic Converters- devices attached to the tailpipe of cars to convert harmful emissions to harmless ones.

Non- Technology Based Solutions

Reducing the number of vehicles used through carpooling

Using alternative transport e.g. walking, bicycling, public mass transit (buses, trains)

Organizing "car free" zones, events and days.

References

Pollution issues <http://www.pollutionissues.com/Ve-Z/Vehicular-Pollution.html>

whatGreenCar? <http://www.whatgreencar.com/impacts.php>

Wikipedia http://en.wikipedia.org/wiki/Automobile_emissions_control

Suggested Teaching Strategies

Although teachers are free to use Information Sheets #1-3 in whatever ways might best suit their unique situations the following suggestions are also available for consideration.

1.
 - a. Present students with Information Sheet #1.
 - b. Use the statistics to illustrate the phenomenal growth rate of car numbers.
 - c. In small groups allow students to brainstorm the reasons car why ownership is important to individuals (social and utilitarian).
 - d. Whole group discussion about the efficiency of fuel consumption of cars

2. Assessing the environmental impact of a car. Using Information Sheet #2 and their own practical inquiry activities students investigate and report on the environmental impact of a car. Practical activities can include:
 - Observing the types of materials that make up a car
 - Testing for the components of tailpipe emissions e.g. carbon dioxide, pH, water vapor, particle emissions
 - Estimating the amount of solid waste produced by the disposal of a vehicle.

3. Jigsaw activity. Divide the class into 3-4 members each. Each group researches and presents a report to the rest of the class on one of the methods of reducing the environmental impact of cars listed on Information Sheet #3. Reports should describe how the method works, its strengths and weaknesses.

4. WISE Activism. Students who are concerned about the negative impact of cars on the environment could be encouraged to develop an action plan to address this issue e.g.
 - Designing an informational brochure or ad about “green” cars
 - Organizing a car-free day in the school or community
 - Designing a plan to reduce car usage by the class or school community

Assessment Rubric

Criteria	Level 1	Level 2	Level 3	Level 4
Knowledge and Understanding	- demonstrates minimal understanding of the functions of the internal combustion engine.	- demonstrates some understanding of the nature of the functions of the internal combustion engine.	- demonstrates considerable understanding of the functions of the internal combustion engine.	- demonstrates a thorough understanding of the functions of the internal combustion engine.
Application	- connects knowledge of the internal	- connects knowledge of the internal	- connects knowledge of the internal	- connects knowledge of the internal

	combustion engine and atmospheric pollution with minimal effectiveness.	combustion engine and atmospheric pollution with blood/conflict diamonds with some effectiveness.	combustion engine and atmospheric pollution with blood/conflict diamonds with considerable effectiveness.	combustion engine and atmospheric pollution with a high level of effectiveness.
Communication	<p>-communicates information with limited clarity</p> <p>- Information is communicated with minimal organization.</p> <p>-employs language skills with limited effectiveness.</p>	<p>- communicates information with some clarity</p> <p>- Information is communicated with some organization.</p> <p>-employs language skills with some effectiveness.</p>	<p>- communicates information with considerable clarity</p> <p>- Information is communicated with considerable organization.</p> <p>-employs language skills with considerable effectiveness</p>	<p>- communicates information with a high degree of clarity</p> <p>- Information is highly organized.</p> <p>-employs language skills with a high degree of effectiveness.</p>