TIER I LESSON:

The Green Mile to School

Big Ideas:

The lesson is designed to accomplish these major goals:

1. Students will critically discuss the global warming issue.
2. Students will investigate and discuss the relationship between greenhouse gas emissions and global warming.
3. Students will make informed decisions involving science and society.

Audience:

Grades 9-12

Note: This lesson is most effective when students have already seen the film: *An Inconvenient Truth.* If they have not, and time does not permit for the entire film, it is suggested that you show the segments listed in the Class Time section of this lesson plan.

Lesson Overview:

In this lesson, students will learn that greenhouse gas (GHG) emissions are not all the same. They will investigate the type and severity of emissions released by different countries, states, industries, and cars. This assignment will challenge students to estimate the impact of each factor on greenhouse gas emissions. They will also examine their own personal activities and find ways to help reduce the damage.

Objectives:

- Understand why the relative impact on global warming may vary depending on where you live, what car you drive, how many miles you drive, and how you live your life.
- Understand how both government and corporate policy impact individual choices and vice versa.
- Represent data illustrating differences in greenhouse gas emissions at various scales.
- Calculate the relationship between gas mileage and carbon dioxide emissions in various automobiles.
- Construct a concept map illustrating the relationships among government policies, individual behaviors, and global warming.
- Evaluate multiple ways in which emissions of greenhouse gases can be reduced in the local community.

National Standards Addressed:

This lesson addresses the following National Science Education Standards:

Content Standard A

As a result of activities in grades 9-12, all students should develop

- Abilities necessary to do scientific inquiry.
- Understandings about scientific inquiry.

Content Standard F

As a result of activities in grades 9-12, all students should develop an understanding of

- Personal health

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- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society

Fundamental concepts and principles that underlie this standard include:

- Human activities can enhance potential for hazards. Acquisition of resources, urban growth, and waste disposal can accelerate rates of natural change.

Risks and Benefits:

- Students should understand the risks associated with:
  - natural hazards (e.g., fires, floods, tornadoes, hurricanes, earthquakes, and volcanic eruptions)
  - chemical hazards (e.g., pollutants in air, water, soil, and food)
  - biological hazards (e.g., pollen, viruses, bacteria, and parasites)
  - social hazards (e.g., occupational safety and transportation)
  - personal hazards (e.g., smoking, dieting, and drinking)
- Individuals can use a systematic approach to thinking critically about risks and benefits. One example is to apply probability estimates to risks and compare them with estimated personal and social benefits.

Teacher Prep Time:

30 minutes *(does not include previewing the film)*

Materials Needed:

- Data sources (see Additional Resources section below) detailing GHG emission standards at the International, National, State, Local, and Individual levels
- Various automobile dealership pamphlets containing information about gas mileage
- Computer with Internet access
- Calculator
- Notecards (for Concept Map creation)
- Copies of Reproducible #1
- Copies of Reproducible #2 (optional)
- Reproducible #3 (optional)
- Copies of Reproducible #4 (optional research extension)

Class Time:

Video: 90 minutes to view entire film: *An Inconvenient Truth*

or

20 minutes to review these sections from the film: Chapter 28, *Balancing the Economy*; Chapter 30, *The Solutions Are in Our Hands*; Chapter 31, *Are We Capable of Doing Great Things?*

Activity: 90 minutes (Additional time outside of class may be required for research.)

Desired Outcomes:

After completing this lesson, students will recognize the relationship among international, national, state, and local policy decisions; corporate decisions; personal decisions; greenhouse gas emissions; and global warming.

Students will work in pairs and later in groups. Be prepared to move desks around in your classroom.

Reproducibles:

This lesson contains several reproducibles. These will provide content for the lesson as well as information for the teacher when planning the lesson and student evaluation.

Background:

Before beginning this lesson:

- Preview the film: *An Inconvenient Truth*
- Seek out media sources for the latest information regarding automobile emissions and global warming.
- Gather data on the amount of GHGs emitted by various countries, states, and automobiles. For example, information on cars should include data on green cars, hybrids, SUVs, economy models, and new prototypes. See Additional Resources for websites.
- Ask students to rank the amount of GHG emissions that various countries, states, and automobiles produce. Also ask them what resources they could use to find the amount of carbon dioxide produced by each.
- Have students calculate the amount of carbon dioxide they generate each year by taking one of these online quizzes:
    - http://www.climatecrisis.net/takeaction/carboncalculator/
    - http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ResourceCenterToolsGHGCalculator.html
- Ask students to discuss the number of miles the average citizen travels in various countries and states. Discuss urban sprawl, carpooling, public transit, carpool (or High Occupancy Vehicle [HOV]) lanes, and other variables that influence the number of miles traveled and how that affects GHG emissions.

Lesson Steps:

Part 1: Anticipatory set

1. Ask students how they got to school and how far they traveled.
2. Ask students whether they are aware of any global patterns that seem to be linked to temperature increases. Students may be aware of a few of these.
3. Allow students to pair up and share their beliefs on the hazards of global warming and the urgent need for remedial action. Tally these results and keep for later.
4. Ask students to brainstorm ways that GHG emissions might be reduced. It is quite possible that this list will lack depth and breadth of knowledge. Keep this list to show students later.

Teacher's Notes:

Part 2: Building knowledge through a consideration of scale

1. Ask students to read **Reproducible # 1: SPATIAL PERSPECTIVE - What we see depends on where we are.**
2. Lead a discussion concerning the scale of global warming. For example, ask students to share their thoughts on how government policies (international, national, state, and local) either contribute to or help to reduce the problem of global warming. Be sure to also ask students to explain why some nations, states, and cities/regions contribute more GHGs than others.
3. Next, connect the discussion to the role of environmental and special interest groups in contributing to or solving global warming.
4. Finally, ask students about their personal impact on global warming. This can include the distance traveled to school and after-school activities, the types and the number of cars in their households, the products they purchase, etc. Have students share the results of their earlier assignment in the Background section to calculate their CO_2 emissions.
5. Divide the class into the following small groups:
    a. Continents
    b. Nations
    c. States
    d. Regions of the state/province where they live
    e. Automobile manufacturers
6. Assign each group member a research topic from among the following categories. Each group member will share this information within his or her group.
    - Economy
    - Lifestyle (e.g., extent of consumerism, numbers of automobiles per household, miles traveled)
    - Urban vs. Suburban—To what extent does this influence the number of miles driven?
    - Fuel efficiency
    - The automobile manufacturers group will want to seek out information on other topics such as: target audience, environmental record, miles per gallon, extent to which their cars are made of recycled materials, and whether they offer hybrid or alternative fuel models.

*Be sure to ask the groups to find information that is representative of the whole range of cases within their assigned category. For example, the Continents group should consider information on all seven continents. The Nations group should discuss information on several different countries from several different regions of the world—some industrialized, some moderately industrialized, and some developing. An excellent web-based application that may be helpful for the Continents and Nations groups is: http://www.breathingearth.net. Automobile manufacturers should consider

Teacher's Notes:

makers of sport utility vehicles, hybrid cars, economy cars, gas-hogs, "green" machines, and some of the new prototype cars. In addition, they should consider the role of public transportation.

7. At the conclusion of the group discussion, have one representative from each group briefly present the group's findings. In particular, ask the representative to share the reasons why disparities exist among the individual cases within his or her assigned category.
8. At the conclusion of the presentations, revisit the questions asked in Part 1 above (Anticipatory set) and tally the results:
    - Will students still get to school in the same way? Why or why not?
    - Can they list ways to reduce GHGs?
    - Do they believe that global warming is an urgent problem? Why or why not?
    - Do Americans travel the same number of miles as citizens from other regions of the world? Does a citizen of California drive as many miles as a citizen of Montana? Why?
    - Can they suggest ways to reduce the number of miles traveled by citizens of various parts of the country and the world?
9. Share with the class the differences between the first tallies and the second tallies.

Assessment:

Note: The assimilation of new concepts often requires time and rigorous mediating activity to help us to refine our learning. The use of concept maps as an assessment tool should provide both. The sequence not only provides ample time for assimilation, but also includes student interaction before, during, and after the unit.

1. Students create an individual pre-concept map that exhibits the cause-and-effect correlation of automobiles, consumer behavior, and government policies (all levels) on global warming.
2. Students share, compare, and discuss their concept maps to create a collaborative map within their assigned groups.
3. Students pursue individual activities and research.
4. Students conclude by creating a final, individualized post concept map as a summative assessment.

To further explain concept maps, you may wish to provide students with a copy of **Reproducible # 2: What Is a Concept Map?**

You may want to use **Reproducible # 3: Concept Map Rubric** to evaluate students' work.

Share this lesson with other teachers in your school:

- a driver's education teacher may reinforce fuel consumption facts
- an art teacher may discuss spatial perspective in his or her classroom

Academic Extensions/Modifications:

There are many variables that affect fuel consumption besides "city and highway" driving. Students interested in the engineering aspects of fuel efficiency may investigate the influence of:

- Frontal area design (i.e., wind resistance or aerodynamic design)
- Spoilers and other wind impeders, such as large side-view mirrors
- Optional equipment such as air conditioners and other electronically powered options
- Tire inflation

Other contributors to fuel consumption:

- Road composition (e.g., concrete, asphalt, gravel, dirt, etc.)
- Road condition (e.g., dry, wet, icy, snowy, etc.)
- Incline (Mileage decreases with every degree of upslope.)
- Weight (e.g., 150 lbs per person; cargo such as luggage, golf clubs, etc.)
- Special equipment such as heavy duty A/Cs, HD axles, or larger fuel tanks (Add 6 lbs of weight per gal.)
- Outside temperature

Enrichment—a Research Option:

1. If time allows, ask students to conduct more thorough research. Provide students with the two-page rubric for science presentation (Student and Self-evaluation), and discuss expectations and concerns. See **Reproducible # 4: Science Presentation Evaluation Rubric.**
2. Each group should be prepared to offer and defend reasons for the differences in GHG emissions within its assigned category. For example, India has a much larger population than the United States, but its residents generally live a more agrarian lifestyle that is less dependent upon fossil fuels. Europe is more urban than Africa. A North American citizen drives more miles to work and consumes more goods that require global transport, etc. *You may distribute various data source handouts for analysis, data representation, synthesis, and presentation by students.
3. When all groups are ready, have each group present its findings to the rest of the class. Use **Reproducible # 4: Science Presentation Evaluation Rubric** for students to evaluate the presentations. Also provide the self-evaluation form for each group to complete.
4. After the groups have presented, ask students to discuss the following:
   - What are the global warming connections among automobile usage, consumer behavior, and government policies?
   - What are some possible ways to reduce emissions (e.g., carpooling, high occupancy vehicle

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lanes, alternative fuels, hybrid cars, riding a bike, walking, etc.)?

- Based on the data presented, which car would they purchase? Why?
- Which car has the least environmental impact? Ask students to be sure to consider other variables besides carbon dioxide emissions and gas mileage.
- Should the government get involved in creating policies? Why or why not?
- How has the introduction of more fuel-efficient cars affected the oil and automotive industries?
- How can each person impact policy?

Additional Resources:

Data sources for greenhouse gas emissions

International emissions:
http://yosemite.epa.gov/oar/globalwarming.nsf/content/EmissionsInternational.html

National GHG emissions:
http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2006.html

State and local emissions:
http://yosemite.epa.gov/OAR/globalwarming.nsf/content/EmissionsLocal.html

Individual GHG emissions:
http://yosemite.epa.gov/oar/globalwarming.nsf/content/emissionsindividual.html

EPA GHG emission calculator:
http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ResourceCenterToolsGHGCalculator.html

EPA Climate Change Site: http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html

The Weather Channel's *Planet in Change* Curriculum:
http://admin.www.weatherclassroom.com/upload/materials/Planet_in_Change_new.pdf

ClimateCrisis.Net (The companion website to the film: *An Inconvenient Truth*):
http://www.climatecrisis.net/

To calculate the quantity of carbon dioxide you generate each year, visit:
http://www.climatecrisis.net/takeaction/carboncalculator/

For information on fuel economy, emissions, etc., including ratings on various car types, visit:
http://www.fueleconomy.gov
and
http://www.weather.com/activities/driving/greenvehicle/?from=drivfl

Mauna Loa Carbon Dioxide data:
http://www.smate.wwu.edu/teched/co-2.html

Breathing Earth (This website displays carbon dioxide emissions for every country on earth):
http://www.breathingearth.net/

SPATIAL PERSPECTIVE

What we see depends on where we are.

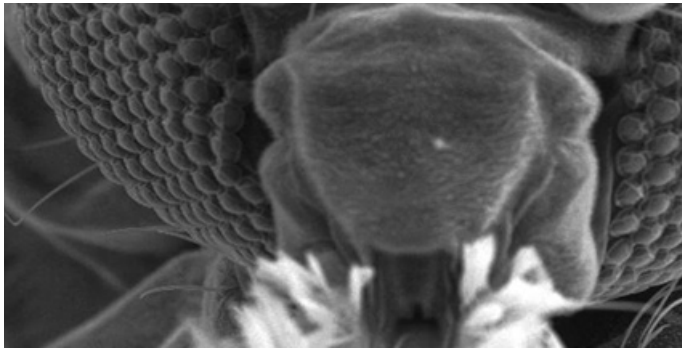
Movie producers often use the idea of spatial perspective when making movies. One method used is called "POV" – or Point Of View. This means that the camera (and the audience) will see a scene just as one of the actors sees it. If there are ten actors in a scene, there are ten possible different POVs. Other spatial perspective methods relate to the distance from the subject in the scene. There is a far shot, medium close-up, close-up, an extreme close-up, and an establishing shot. An establishing shot is an initial reference shot used to frame the setting of the scene. For example, an establishing shot may show the outside of a court house where a trial will be held in the upcoming scene.

The same principles apply in science. Your understanding of a subject will often depend on your point of view and how close or far you are from that subject. For instance, have you ever seen a photo that you thought was a moonscape with valleys and craters, and then found out that you were looking at a magnified picture of skin? The lighting and extra close-up of an electron microscope made the pores look like the pockmarked surface of the moon. Or, perhaps you were looking at what appeared to be beautiful flower petals waving in the breeze, and the camera backed up to reveal a terrifying-looking creature. But wait — it's only a closeup of a mosquito! (See photos at right.) It's all about perspective. Distance, angles, lighting, and position all affect your perception of the image.

A global perspective

Spatial perspective takes on an added dimension when applied to the subject of global warming. It's hard to know what you are looking at until you step away and see the bigger picture.

Many people do not understand the real threat of global warming because they are standing in the wrong place. To fully grasp the danger, they need an "establishing shot." They have to take a step back and a step up from where they are. The neighborhood may look the same, but if they can see the entire planet and the damage that has been done in the last one hundred years, the changes that have occurred will be very clear. Global warming is not about point of view. It's about survival.



Photos courtesy of the Centers for Disease Control and Prevention/Janice Carr

What Is a Concept Map?

Concept maps are graphical representations that show relationships among information. Major concepts are linked by words that describe their relationship. These maps can help you organize and enhance your knowledge on any topic, as well as measure your learning progress; they reveal previous knowledge and deficits in knowledge. Improper links or wrong connections can show a teacher exactly which concepts you are having trouble understanding.

Concept maps may be drawn or built using note cards. This building process allows you to arrange and rearrange the layout of your concept maps before deciding on a final version. You can present your concept maps to the class, each presentation serving as a way to teach classmates about a different aspect of the topic at hand. Concept maps may also be used as an assessment tool.

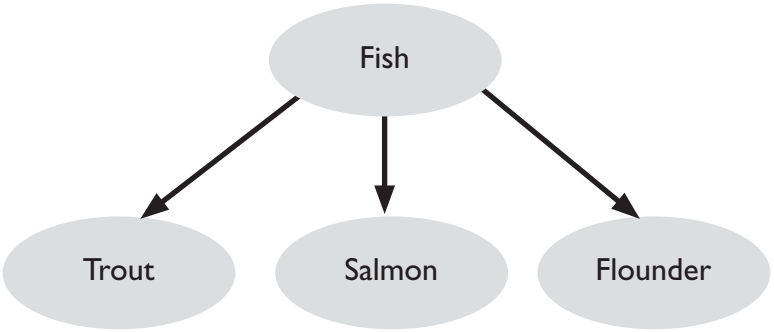
Concept Map Resources: To view some examples of concept maps, concept mapping software, and instructions for use, refer to the following websites:

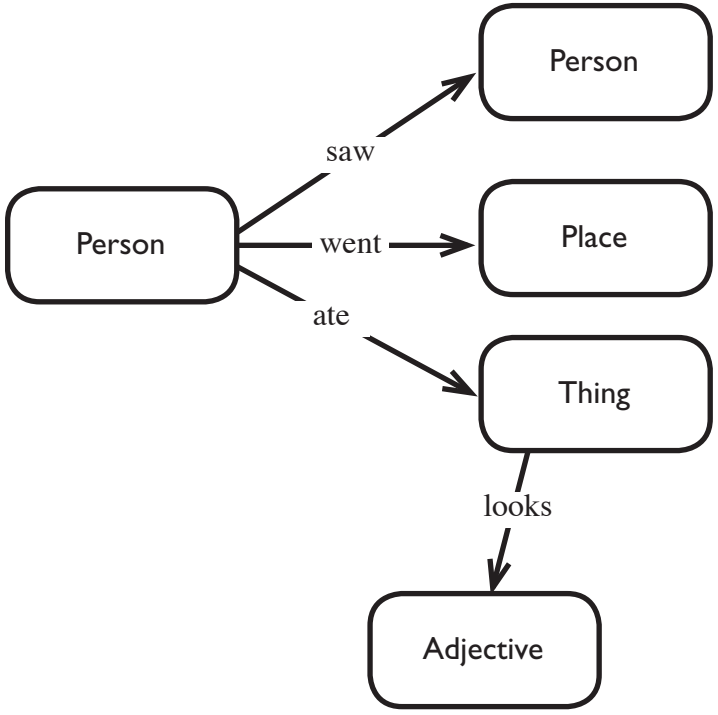
http://www.graphic.org/concept.html

http://www.flaguide.org/cat/minutepapers/conmap7.php

http://cmap.ihmc.us/

http://www.socialresearchmethods.net/kb/conmap.htm





Concept Map Rubric

Alternative Concept Map Scoring Rubric

*Developed by Robert Corbin and Angelique Seifert

Bloom's Higher/Lower Order Thinking	Points
Knowledge and Comprehension	1
Application and Analysis	2
Synthesis and Evaluation (Attitude)	3
Ausubel's Cognitive Learning Theory after Novak and Gowin, 1984 Relationships of Linkage and Reasoning Indicators	
Hierarchical (Scored for overall extent; 1 point for each identified level)	H1 – H5
Differentiation (Scored for the overall extent of refinement and/or specificity and explanation of response)	D1 – D5
Cross Concept Linkage (Each individual response between concepts)	C1

The purpose of a concept map is to measure changes in a student's cognitive framework. Generally speaking, students will receive overall higher scores for responses reflecting higher order thinking.

Scoring for Bloom's Scale of Higher and Lower Thinking:
When scoring an answer, consider each of the three categories (Knowledge and Comprehension, Application and Analysis, and Synthesis and Evaluation), and score accordingly. Therefore, each answer is scored and there is a wide range of total number of points that could be accrued.

Scoring for Ausubel's Cognitive Learning Theory:
This aspect of the scoring rubric utilizes three of Ausubel's ideas concerning cognitive frameworks, hierarchy, differentiation, and cross concept linkage.

- Hierarchy – When scoring for the extent of hierarchical placement of responses, look for an overall trend from general to more specific concepts, and assign one hierarchical point value for the total map. For example, if you can identify four distinct levels of hierarchy, assign a score of H4.
- Differentiation – When scoring for the extent of differentiation, look for specific responses that indicate a refinement of knowledge concerning each concept depicted. For example, if a concept is explained in specific detail, the score may be a D4 or a D5.
- Cross Concept Linkage – When scoring for cross concept linkage, look for lines that connect concept to concept, or drawn additions to the map. Score each line or drawn addition.

Science Presentation Evaluation Rubric

Assignment:				
Student Name:		**Score:**		
This analytic rubric is used to verify specific tasks performed during a student presentation. If the task has been completed, all points are awarded. No points are awarded if the task is not complete.				
Category	**Scoring Criteria**	**Points**	**Student Evaluation**	**Teacher Evaluation**
Organization ***15 points***	The type of presentation is appropriate for the audience.	**5**		
	Information is presented in a logical sequence.	**5**		
	Presentation appropriately cites two references or more.	**5**		
Content ***35 points***	Introduction piques interest and establishes the speaker's credibility.	**5**		
	Scientific terms are defined	**10**		
	Presentation is accurate.	**10**		
	There is a logical summary of the presentation.	**10**		
Presentation, ***Oral*** **or** ***Other*** ***50 points***	*Oral* Good eye contact is maintained with audience. *Other* Presentation is visually interesting.	**10**		
	Oral Speaker's voice is clear and audible. *Other* Presentation can be viewed easily from anywhere in the room.	**10**		
	Oral Speaker uses appropriate body language. *Other* Presentation is artistically pleasing but not distracting.	**5**		
	Oral Correct pronunciation of words and proper use of language. *Other* Grammar and punctuation are correct.	**5**		
	Oral A visual aid is used for support. *Other* Presentation properly cites author(s).	**5**		
	It is clear that the presentation has been practiced and that it is based on results from reliable sources.	**10**		
	Presentation meets time restrictions.	**5**		
Score	**Total Points**	**100**		

Self-evaluation

Evaluate your group's performance honestly by selecting the appropriate rating.

	Criteria		Complete	Partial	Not at All
Presenter	Preparation	The presentation is well thought out and thoroughly prepared.			
	Posture	Posture is appropriate throughout the presentation.			
	Eye contact	Good eye contact is maintained with the audience.			
	Language	Language and pronunciation are used properly.			
	Vocal	Uses a clear voice, easily heard at the back of the room.			
Content	Logic & flow	Sequential outline; connects results from the experiment.			
	Length	Stayed within the assigned time requirement.			
Speaker Support Materials	Visual aids	At least one well-prepared visual aid representing gathered data is properly labeled and used for support.			
	Viewability	Easily viewed from a distance			
	Artistic merit	Artistically pleasing without being distracting			
	Grammar	Good writing skills and punctuation			

About the Curriculum Author:

Robert Corbin is a National Board Certified Science Teacher serving the Charlotte Mecklenburg School System (CMS) as Earth Science Academic Content Coach. He is a founding member of the Bank of America Teaching Fellows and Affiliates program and science facilitator for the National Board Teacher Support Program for CMS. Robert has taught a variety of technology and science courses in a number of public high school, middle school and university settings for about 20 years. He is a Christa McAuliffe Fellow, Duke University Sawyer Fellow, Time Warner Cable All Star Teacher, Ben Craig Award recipient, Omnicron Psi Outstanding Science Teacher, Whitehead Educator of Distinction, and NAGT Outstanding Earth Science Teacher of the Southeastern United States. Robert has received grants and awards from the EPA, NAGT, Bank of America, First Union Bank, Wachovia Bank, Toyota Tapestry Program, International Paper Corporation, Virtual High School Concord Consortium, Noyce Foundation, North Carolina Department of Public Instruction and Christa McAuliffe Foundation. He has written science curriculum for the Weather Channel, Environmental Literacy Council, American Society for the Prevention of Cruelty to Animals, the Duke Talent Identification Program, North Carolina Department of Public Instruction and the Weyerhaeuser Corporation. He has a B.S. in Environmental Science and an I.M.A. in Natural Science Education.

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