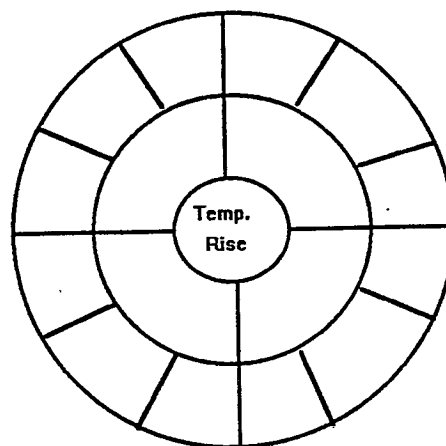
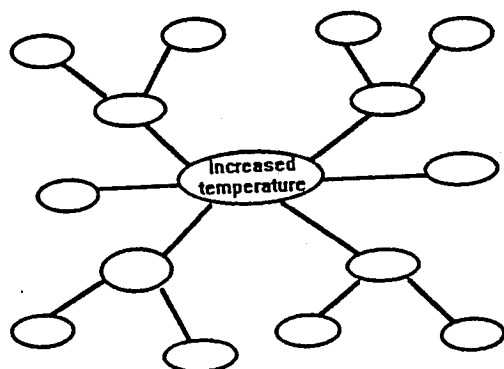


Teaching Activity: Environmental Chain Reaction

Background: The issue of global warming has been transformed from one of concern to a small group of scientists to an item on the agenda of world leaders. As an aid to thinking about multiple interconnections of this important topic, or any topic with wide ranging implications, the techniques of the "future wheel" can be used. One of the initiators of this technique was the Acid Rain Foundation, which used it in conjunction with that problem.

The technique involves starting with a "What if.....?" and responding with as many consequences as possible. These are arranged around the original "What if.....?" and connected to it through consecutive circles radiating out from the center. The primary consequences themselves have secondary consequences in the next circle out, etc. The size of the wheel (the number of connecting circles) can be changed depending upon the ability level of the group. An option is to use a concept web format where individual consequences can be arranged around a center circle and radiate out like the spokes of a wheel.

Possible Formats:



Information can be presented in a variety of ways and is totally dependent upon the teacher's intentions and the age and ability level of the students involved :

- through informational reading selections (i.e., Stephen Schneider's book, Global Warming: Are We Entering the Greenhouse Century? or John Gribben's book Hothouse Earth);
- by brainstorming a list of consequences with the entire class;
- by providing students with a prepared list;

Objectives:

- To communicate the concept of a chain reaction regarding environmental events;
- To evaluate environmental events and how they might influence life on Earth;

Important Terms: Chain reaction, global warming, consequences, primary, secondary, evaluate, compare;

Materials: Butcher paper, markers (red, green, black) , "Post-Its", copies of blank "effects wheel" or concept web, paper, pencil, reading materials or list of consequences, overhead transparency machine, overhead transparencies of effects wheel /concept web;

Procedure:

1. Organize students into groups of 3- 4.
2. Pass out either the informational reading selections or the lists of environmental consequences.
 - Discuss the list with the class.
 - As students read, they should underline or circle events that would result from an increase in the average global temperature.
3. On a sheet of paper, students should make two columns, one for **Positive Effects** and one for **Negative Effects**.
 - Events that are considered beneficial should be listed in the **Positive** columns.
 - Events that are considered detrimental should be placed in the **Negative** column.
4. Help students to see the cause and effect relationship that exists between the events:
Example: Ice caps melt ----- sea level rise ----- coastal flooding
5. Provide overhead transparency machines for students to use in creating large copies of the effects wheel.
6. Working in their groups, students should write one "effect" on each " Post It " sheet.
7. Students should place their predicted results on the effects wheel beginning in the center of the wheel and working out.
 - The center space should indicate the average global temperature that their group has decided upon, ranging from 1-9 degrees C.
 - Primary effects of the temperature rise should be placed in the next circle, etc.
8. When the group is comfortable with the sequence of events that they have decided upon, the "Post-Its" can either be glued or taped in place, or the effects can be written permanently on the wheel.

- The "Post Its" should be moved around the wheel until the group is comfortable with the arrangement.
9. Students should use markers to indicate whether the effects are positive, negative or a combination of the two.
 - Positive effect -----Red
 - Negative Effect -----Green
 - Combination effect -----Black
 10. As a group, students should prepare short statements summarizing the configuration on their effects wheel and stating whether they feel global warming would have a positive or negative on the Earth's systems.
 11. Effects wheels should be posted around the room for other groups to evaluate and compare with.

Global Warming Background Information

Have you ever gotten into a car that has been left in the sun on a hot day with its windows shut and found it very hot? If so, you have experienced the "greenhouse effect"! When sunlight is absorbed by the car seats, it is converted into heat (infrared) energy. The glass of the car windows blocks much of this heat energy as it tries to escape back out into the air. This raises the temperature inside of the car. Carbon dioxide, methane, water vapor and other gases in the atmosphere act somewhat like the glass of the car when they absorb and hold the heat that the Earth normally radiates back out into space. Thus, "greenhouse gases" trap heat and theoretically, could cause a warming of the Earth.

Some scientists are concerned that the temperature of Earth's atmosphere may be increasing due to an "enhanced" greenhouse effect caused by human activities. Since the mid-1800's, we have been emitting large amounts of carbon dioxide, methane and nitrous oxide into the atmosphere by burning large amounts of fossil fuels (oil, coal and natural gas). At the same time, we have been cutting down large tracts of forests (deforestation) that would normally remove the excess carbon dioxide from the air through photosynthesis.

The average global temperature of the Earth has been rising since the mid-1800's as well. While there have been some fluctuations, the general trend has been toward increasing temperatures. Since 1880, average global temperatures have increased about 0.7 degrees C (1.2 degrees F). The decade of the 1980's was the warmest decade on record.

To many people, warmer temperatures may seem desirable. However, most scientists agree that a significant warming would have many harmful effects. Lower heating costs might be offset by higher air conditioning costs. Areas that now grow most of the world's crops might become too warm or too dry to grow food. Areas that would become warmer, such as much of Canada, often don't have soils that are suitable for growing most food crops. Lower water levels in freshwater lakes would concentrate pollutants. Weather patterns would change and hurricanes would hit the coast farther north and with greater ferocity. Warmer temperatures would expand the volume of the oceans and melt much of the ice in glaciers and polar ice caps. This would raise the level of the oceans, flooding many of the coastal cities, where about one third of the world's population lives. Entire (populated) island chains would disappear under the sea! Barrier islands and reefs would disappear, exposing the coast to increased erosion. For these and many other reasons, global warming is something that many scientists are very concerned about.

At the same time, there are other scientists that are not convinced that global warming is occurring at this time, or if it is, that it is due to human activities. They point out that the Earth's average global temperature has fluctuated since the Earth was formed. Some say that the observed temperature increase may simply be due to natural causes and that there is nothing that we can do about those causes. Others question the validity of the temperature measurements themselves. Many of the data collecting sites are in or near large

cities where colleges and universities are found. These areas have changed significantly over the last 100 years and many of the changes, asphalt streets, industrialization, and taller buildings that interfere with wind circulation, could result in local warming that does not necessarily reflect increased global temperatures.

Carbon dioxide is thought to be responsible for about 55-60 percent of the global warming trend. Increased carbon dioxide from fossil fuel burning coupled with reduced carbon dioxide removal from deforestation have resulted in an increase in carbon dioxide levels in the atmosphere from about 314 parts per million (ppm) in 1958 to about 348 ppm in 1988.

Chlorofluorocarbons (CFCs) are thought to be responsible for about 25 percent of the global warming trend. CFCs are used in air conditioners and refrigerators, and in the production of plastic foams, in various industrial processes and in aerosol propellants.

Methane is thought to be responsible for about 12 per cent of the global warming trend. It is produced by anaerobic bacterial decay of decomposing matter and in the digestive tracts of cattle, sheep, termites, and other organisms. Some escapes from industries and other man-made sources.

Nitrous oxide is responsible for about 6 percent of the global warming trend. It is produced by the breakdown of nitrogen fertilizers, livestock wastes, and by burning of various fuels.

Even though not all scientists believe that global warming is occurring, most would agree that we should take some steps to reduce the release of the air pollutants that are thought to cause it. Regardless of whether global warming is occurring or not, those steps would help to reduce air pollution and save energy. Some things that are recommended are:

- stop producing and using CFCs or at least greatly reduce their production;
- reduce the use of fossil fuels by increasing the use of renewable alternative energy sources;
- increase the use of air pollution control devices;
- stop clearing and burning forests;
- reforest as much as possible;
- reduce water pollution, which depletes aquatic plants which remove carbon dioxide;
- slow human population growth to a sustainable level;
- encourage passage of laws to help- protect the environment;

While the debate over global warming continues, time passes. Should we do nothing now, wait for more data and hope that the concerns about global warming are without merit? Should we act now and hope that it is not too late?

Possible Consequences of Global Warming

1. Increased evaporation of water from the oceans to the atmosphere;
2. Increased frequency and severity of storms;
3. Expansion of water in ocean basins;
4. Restrictions and rationing of water;
5. Increased length and frequency of cold and hot periods;
6. Change precipitation patterns (high ---low; low to high)
7. Intense beach and wetland area destruction;
8. Constant smog/ low level ozone alerts;
9. Respiratory and other health problems;
10. Rising sea level
11. Melting of polar ice caps and mountain glaciers;
12. Intrusion of salt water into freshwater systems;
13. Loss of freshwater fisheries, reservoirs, nesting areas;
14. Increased use of air conditioning/ heating systems;
15. Continued / intensified use of fossil fuels;
16. Change in agricultural zones;
17. Exposure of toxic dumps as water levels drop;
18. Loss of small farms; agricultural collapse;
19. Increased immigration to urban areas;
20. Loss of wildlife habitat;
21. Warmer /colder winters; cooler/ hotter summers;
22. Increased cloud cover;
23. Increased power outages;
24. Increased wildfires over large areas;
25. Loss of / increased soil moisture;
26. Increased deforestation;
27. Economic development of northern regions;
28. Loss of / damage to transportation systems;
29. Unemployment increases;
30. Loss of biological diversity of both plants and animals;

