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ABSTRACT

This volume contains 36 lessons designed to be used in secondary social studies classes to introduce the science/technology/society (STS) themes and issues. While the first 11 lessons focus on general STS themes, the other 25 lessons cover specific STS issues that fall under such categories as population growth, water resources, world hunger, food resources, air quality, war technology, energy shortages, land use, human health, disease, hazardous substances, plant and animal extinction, nuclear reactors, and mineral resources as well as scientific ethics and scientific inquiry. Except for the first three lessons, all the lessons contain: (1) an introduction that provides a brief overview of the content and the teaching strategies used; (2) objectives for student learning; (3) subject and grade level recommendations; (4) time allotment; (5) required materials and preparation; (6) step-by-step procedures; (7) suggestions for evaluation; (8) ideas for extension and enrichment; and (9) additional resources to enhance learning. The class activities vary from short, easy to use lessons requiring little preparation to others that require more time and are more effective as introductions to STS units. A variety of teaching strategies are employed that include case studies, role playing, debates, discussion groups, decision making, simulations, small group work, and data analysis. Three planning matrices are included to help with the use of the lessons. (DJC)

POLLUTION BIOMEDICAL ETHICS AU... GENETIC ENGINEERING
BOTICS CRYOGENICS GENETIC ENGINEERING
OMPUTERS ENERGY NON-RENEWABLE RESOURCES
OXIC WASTES SPACE STATION SPACE TRAVEL LAS

SCIENCE
TECHNOLOGY
SOCIETY

MODEL LESSONS
FOR SECONDARY SOCIAL STUDIES CLASSES

Edited By Robert D. LaRue, Jr.

SOCIAL SCIENCE EDUCATION CONSORTIUM, INC.

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...SUPPORT SYSTEMS IN VITRO FERTILIZATION PUBLI...
...DEVELOPMENT POPULATION GROWTH E...
...ACID RAIN DEPLETION OF OZONE

SCIENCE/TECHNOLOGY/SOCIETY: MODEL LESSONS FOR SECONDARY SOCIAL STUDIES CLASSES

Robert D. LaRue, Jr., Editor

Social Science Education Consortium, Inc.
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CONTENTS

1. INTRODUCTION

Importance of Education on Science/Technology/Society

Modern societies, such as the United States, are increasingly propelled and changed by advances in science and technology—distinct and synergistic ways of knowing about and altering the world. Sciences (processes of knowing about nature and society) and technology (ways of using knowledge to satisfy human needs or wants) are combined in modern societies to provide increasing human control over natural and social environments. Tremendous, ongoing achievements have spawned great hopes, fears, and controversies associated with a plethora of developments (e.g., nuclear power, genetic engineering, organ transplantation, robotics, pesticides).

In a democracy, citizens have the right and responsibility—as voters, consumers, workers, and office holders—to participate in decisions about issues related to social uses of science and technology. The success of individuals and their society is tied to the quality of these choices, which varies with the knowledge and cognitive skills of decision makers. The vitality of our American democracy depends upon widespread ability of citizens to think effectively about developments in science and technology and their effects on the world. Therefore, a central mission of American schools should be education on science and technology in a social context.

Thus, the position statement on science, technology, and society, adopted by the National Science Teachers Association in 1982, states, in part: "Many of the problems we face today can be solved only by persons educated in the ideas and processes of science and technology. A scientific literacy is basic for living, working, and decisionmaking in the 1980s and beyond."[1]

Similarly, the position statement developed by the Science and Society Committee and adopted by the National Council for the Social Studies Board of Directors in 1982 states: "The impact of science and technology upon society, be it an environmental impact study, the energy problem, or other timely occurring issues, indicates a need for social studies and science educators alike to develop guidelines for teaching about science-related social issues. Science is a social issue, and the examination of scientific issues offers an excellent opportunity for helping students develop a synthesized perspective on science-related issues, a synthesis of the technical data coupled with social, political, economic, ethical, and philosophical information."[2]

These two position statements give major responsibility for education about social issues related to science and technology to teachers. Teachers must rethink the role they play in the development of STS education, particularly in reflecting the constant shifts in values, the need for an increased knowledge base, and the implementation of processes that convey knowledge while including students in active, participatory learning.

The introduction of STS issues and themes into the science and social studies curricula offers unique opportunities to achieve these goals. Whether STS is infused into an existing course or used as the foundation for a course, STS content should be presented so as to encourage students to think about the social and personal implications of the issues.

Purpose of This Project

To help educators meet this challenge, the Social Science Education Consortium has undertaken a project entitled "Building Support Networks for Improved Science/Technology/Society Education." Funded by the National Science Foundation, the project has developed a series of STS resources helpful to both science and social studies educators.

Science/Technology/Society: A Framework for Curriculum Reform in Secondary School Science and Social Studies provides a guide for designing units of study that integrate knowledge from science and social studies. Included are guidelines for selecting STS content, developing skill in analyzing STS issues, developing positive attitudes toward science and technology, assessing options for the design of STS curricula, and infusing STS into secondary science and social studies courses. The *Framework* also presents a powerful rationale for the STS curriculum movement.

Science/Technology/Society: Training Manual can be used by teachers, department chairs, curriculum supervisors, and other educators to design a training program covering the following phases of program development: building a rationale for STS, determining the most appropriate fit for STS issues in the curriculum, developing an integrated approach for teaching about STS issues, selecting and developing STS materials, and evaluating the STS program.

Science/Technology/Society: Model Lessons for Secondary Social Studies Classes and *Model Lessons for Secondary Science Classes* exemplify the guidelines provided in the curriculum framework and training manual. Although the lessons were designed for infusing STS topics into the science and social studies curricula, they could also be grouped to create an STS unit or be combined with other materials to form the basis for an STS course. Many of the activities are extant lessons identified as dealing with STS issues and themes. For each such activity, the original source is listed, thus enabling the user to locate additional materials with potential STS emphasis. Other lessons were developed by project staff to ensure at least modest coverage for each of the sources within the science and social studies curricula.

There is some overlap between the two volumes. However, users will find that some lessons provided only in the social studies volume, for example, are also useful in science classes. To facilitate maximum use of all the lessons, the matrices in the second section list all the lessons in both volumes.

Content and Organization of the Model Lessons

This volume contains 36 lessons suitable for use in secondary social studies classes. The companion volume contains 35 lessons intended primarily for science classes. Except for the first three lessons, which are quick "grabber" activities, all the lessons are presented in a standard format. Each begins with an **Introduction**, which provides a brief overview of the lesson's content and the teaching strategies used. Student learning **Objectives** are listed, as are recommendations for the **Subject and Grade Level** for which the activity can be used. The **Time Required** to use the activity is given. Any **Materials and Preparation** needed are described. Step-by-step **Procedures** are presented; included are questions that can be used to stimulate discussion, probe the issue, or debrief a discussion or other activity. Suggestions for **Evaluation** of the activity are provided. Finally, ideas for **Extension and Enrichment** are given. In some cases, additional **Resources** that could be used to enhance learning about the lesson topic are listed.

The model lessons are divided into two major sections. First are "starter" activities that are included to help stimulate awareness about STS topics or issues and to help students brainstorm, generate discussion, and explore ideas about STS issues. Many of these activities are short and easy to use, requiring minimum preparation and disruption from the regular curriculum. Others require a bit more time to use and are thus probably most effective as introductions to longer STS units.

In the second section are those lessons that focus on particular STS issues. The lessons are loosely grouped according to the following list of STS issues developed by Rodger Bybee[3] and ranked in this order of importance by U.S. science educators:

- Population growth
- Water resources
- World hunger and food resources
- Air quality and atmosphere
- War technology
- Energy shortages
- Land use

- Human health and disease
- Hazardous substances
- Extinction of plants and animals
- Nuclear reactors
- Mineral resources

Each volume also includes a few activities on such other issues as scientific ethics or scientific inquiry.

These lessons require anywhere from one class period to one week to complete. They can be included in science or social studies courses to help enrich the existing curriculum materials and provide an STS focus. The lessons employ a variety of teaching strategies, including case studies, role playing, debates, discussion groups, decision-making, simulations, small-group work, data analysis, and so on. Note that as these are model lessons, the strategy used in an individual lesson can often be adapted to other issues or periods of history.

To facilitate use of the lessons, the following section presents three planning matrices. The first lists the lessons in this volume, indicating in which secondary social studies courses each can be most easily integrated. The second lists the lessons in the science volume, indicating those that can also be used in social studies courses. Certainly, lessons may be used in courses other than those marked in the matrices, which are intended to show only the most obvious links. The first two matrices also indicate the STS issue that is the major focus of each lesson. The final matrix lists the lessons in both volumes according to the primary teaching strategy used in each.

Notes

1. National Science Teachers Association, *Science-Technology-Society. Science Education for the 1980s* (Washington, DC: NSTA, 1982).

2. Science and Society Committee of the NCSS, "Guidelines for Teaching Science-Related Social Issues," *Social Education* 47 (April 1983), p. 258.

3. Rodger W. Bybee, "Teaching About Science-Technology-Society (STS). Views of Science Educators in the United States," *School Science and Mathematics* 87 (April 1987), pp. 274-85.

2. MATRICES FOR PLANNING USE OF THE LESSONS

Matrix of Lessons in This Volume by Social Studies Course

Lesson	STS Issue	World Geography	U.S. History	World History	Civics	Government	Economics	Sociology/ Psychology	Current Events
1. Short Takes	Adaptable to	X	X	X	X	X	X	X	X
2. Mobiles in the Classroom	any issue	X	X	X	X	X	X	X	X
3. STS Scavenger Hunt		X	X	X	X	X	X	X	X
4. The Technology Tree		X	X	X	X	X	X	X	X
5. Knowledge, Skills, and Attitudes for the Year 2000		X	X	X	X	X	X	X	X
6. Reaction Statements Warm-Up		X	X	X	X	X	X	X	X
7. Trivialized Technology			X				X	X	X
8. Science and Technology in the News		X	X	X	X	X	X	X	X
9. STS in My Life		X	X	X	X	X	X	X	X
10. Ten Inventions That Changed Our Lives		X	X	X	X	X	X	X	X
11. Bumper Sticker Position Statements		X	X	X	X	X	X	X	X
12. World Population Growth	Population growth	X		X				X	X
13. Energy Production and Population	Population growth and energy	X		X					X

Lesson	STS Issue	World Geography	U.S. History	World History	Civics	Government	Economics	Sociology/ Psychology	Current Events
14. Fish Kill in Riverwood	Water resources				X	X	X		X
15. Solving the Problems of the World	Food resources, population growth	X							X
16. It's a Natural!	Food resources						X		X
17. Furrows to the Future	Food resources	X	X	X					
18. People and Machines	Food resources, technology and the economy	X	X				X	X	
19. Doing Something About the Weather	Air quality and atmosphere		X		X	X			X
20. Simulating the Strategic Defense Initiative	War technology		X			X			X
21. The Effects of Individual Actions on Technology and Society	War technology		X	X		X			
22. Giving Up the Gun	War technology			X					
23. Renewable Energy and the American Age of Wood	Energy shortages		X				X		
24. Energy Milestones	Energy shortages		X				X		
25. Preparing Environmental Impact Statements	Land use	X			X		X		
26. The Freeway Planning Game	Land use	X			X	X	X		

Lesson	STS Issue	World Geography	U.S. History	World History	Civics	Government	Economics	Sociology/ Psychology	Current Events
27. The Organ Hunter	Human health and disease					X			X
28. Warning Future Generations	Hazardous substances, nuclear reactors	X				X			X
29. The Environment and Participatory Democracy	Environmental protection				X	X			X
30. A Resource-use Warm-Up	Mineral resources	X	X				X		
31. The Ocean Resources Game	Mineral resources	X				X			X
32. God and the Alarm Clock	Technology and change			X					
33. A Social History Approach: Machine and Social Change in Industrial America	Technology and change		X				X	X	
34. Technology and Transportation	Technology and change		X				X	X	
35. Science, Technology, and the Constitution	Government		X		X	X			
36. The Structure of Scientific Revolutions	Scientific inquiry		X	X				X	

Matrix of Lessons in Companion Volume by Social Studies Course

Lesson	STS Issue	World Geography	U.S. History	World History	Civics	Government	Economics	Sociology/ Psychology	Current Events
1. Short Takes	Adaptable to		Duplicated from this volume						
2. Technology Mind Walk	any issue	X	X	X	X	X	X	X	X
3. Technology Timelines		X	X	X	X	X	X	X	X
4. The Futures Wheel		X	X	X	X	X	X	X	X
5. Global and Local Issues		X	X	X	X	X	X	X	X
6. Determining Priorities		X	X	X	X	X	X	X	X
7. Technology and Advertising		X	X	X	X	X	X	X	X
8. Science and Technology in the News			Duplicated from this volume						
9. STS in My Life			Duplicated from this volume						
10. Ten Inventions That Changed Our Lives			Duplicated from this volume						
11. Bumper Sticker Position Statements	↓		Duplicated from this volume						
12. Population Control: Where Do You Stand?	Population growth	X							X
13. Groundwater Rights	Water resources				X	X			
14. Food Additives	Food resources						X		X

Lesson	STS Issue	World Geography	U.S. History	World History	Civics	Government	Economics	Sociology/ Psychology	Current Events
15. Environmental Impact Statements	Air quality and atmosphere		X						X
16. What Would You Do If...?	Air quality, energy				X	X			
17. Collecting Points of (pH)iew	Air quality								X
18. The Biological Effects of a Nuclear Explosion	War technology								
19. Energy Sources	Energy shortages		X						
20. Energy Sources in the Good Old Days	Energy shortages			X					
21. Life Without Petroleum	Energy shortages		X						X
22. Land Use	Land use				X	X			
23. The Artificial Heart: A Technological Alternative	Human health and disease control								X
24. The Benefits of Technology: Conquering Disease	Human health and disease control			X					X
25. Genetic Screening	Human health and disease control								X
26. The Pine Beetle Controversy	Hazardous substances					X			X
27. Pesticides: A Global Problem	Hazardous substances	X					X		X
28. Biodegradable and Nonbiodegradable	Hazardous substances								X

Lesson	STS Issue	World Geog-raphy	U.S. History	World History	Civics	Govern-ment	Eco-nomics	Sociology/ Psychology	Current Events
29. Letters to the City Council	Hazardous substances				X	X			
30. Ecology and the Government	Extinction of plants and animals					X			
31. Forest Products All Around Us	Extinction of plants and animals	X							
32. Nuclear Energy: Risks Involved in a New Technology	Nuclear reactors								
33. Can We Continue to Use Things Up?	Mineral resources				X	X			
34. Soil Deterioration	Mineral resources	X							
35. Scientific Experimentation with Animals	Ethics								X

Matrix of Lessons by Teaching Strategy*

Strategy	Science Lessons	Social Studies Lessons
Brainstorm	Technology Mind Walk The Futures Wheel Technology and Advertising Energy Sources In the Good Old Days Pesticides Forest Products All Around Us	Knowledge, Skills, and Attitudes for the Year 2000 It's a Natural! Bumper Sticker Position Statements
Case Studies	Environmental Impact Statements Land Use The Benefits of Technology Genetic Screening The Pine Beetle Controversy Letters to the City Council Ecology and the Government Soil Deterioration	People and Machines Doing Something About the Weather
Classifying	Population Control: Where Do You Stand? Food Additives Forest Products All Around Us	Knowledge, Skills, and Attitudes for the Year 2000 It's a Natural!
Data Analysis	Technology and Advertising Science and Technology in the News Food Additives Collecting Points of (pH)iew Energy Sources	Science and Technology in the News World Population Growth Energy Production and Population Preparing Environmental Impact Statements
Debate/Panel Discussions	Scientific Experimentation with Animals Soil Deterioration	Doing Something About the Weather The Organ Hunter
Field Experiences	Soil Deterioration	

*Note: Discussion is part of virtually every lesson, so it is not listed here.

Strategy	Science Lessons	Social Studies Lessons
Interview	Ten Inventions That Changed Our Lives Energy Sources in the Good Old Days	Ten Inventions That Changed Our Lives
Problem Solving/ Decision Making	What Would You Do If ...? Energy Sources The Artificial Heart Genetic Screening Ecology and the Government Scientific Experimentation with Animals	Solving the Problems of the World The Effects of individual Actions on Technology and Society Renewable Energy and the American Age of Wood
Reading	Ten inventions That Changed Our Lives Collecting Points of (pH)iew The Biological Effects of a Nuclear Explosion The Artificial Heart Pesticides Biodegradabie and Nonbiodegradable Nuclear Energy Can We Continue to Use Things Up? Scientific Experimentation with Animals	Ten Inventions That Changed Our Lives People and Machines Renewable Energy and the American Age of Wood The Organ Hunter God and the Alarm Clock
Resource Person	Food Additives	The Environment and Participatory Democracy The Structure of Scientific Revolutions
Role Plays/ Simulations	Groundwater Rights Land Use	Fish Kill in Riverwood A Social History Approach: Machine and Social Change in Industrial America World Population Growth Simulating the Strategic Defense Initiative The Freeway Planning Game A Resource Use Warm-Up The Ocean Resources Game

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Strategy	Science Lessons	Social Studies Lessons
Small-group Cooperative Learning	Determining Priorities What Would You Do If ...? The Biological Effects of a Nuclear Explosion The Benefits of Technology The Pine Beetle Controversy	Knowledge, Skills, and Attitudes for the Year 2000 Solving the Problems of the World Furrows to the Future Giving Up the Gun Preparing Environmental Impact Statements Warning Future Generations Technology and Transportation Science, Technology, and the Constitution
Survey/ Inventory	Global/Local Issues Science and Technology in the News Collecting Points of (pH)iew Biodegradable and Nonbiodegradable Nuclear Energy	Science and Technology in the News STS Scavenger Hunt Knowledge, Skills, and Attitudes for the Year 2000 Reaction Statements Warm-Up
Using or Creating Graphics	Technology Timelines The Futures Wheel Ten Inventions That Changed Our Lives Bumper Sticker Position Statements Energy Sources Life Without Petroleum Forest Products All Around Us The Technology Tree	Mobiles In the Classroom Technology Tree Trivialized Technology Ten Inventions That Changed our Lives Bumper Sticker Position Statements World Population Growth Energy Production and Population Solving the Problems of the World Furrows to the Future The Effects of Individual Actions on Technology and Society Energy Milestones Technology and Transportation Science, Technology, and the Constitution
Writing	Life Without Petroleum Letters to the City Council	Fish Kill in Riverwood Renewable Energy and the American Age of Wood Warning Future Generations Bumper Sticker Position Statements

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3. INTRODUCTORY LESSONS

1. SHORT TAKES

The "short takes" teaching strategy was developed by Richard Brinckerhoff, a science teacher at Phillips Exeter Academy in New Hampshire. Brinckerhoff began to accumulate bits and pieces of information and turn them into short items any science teacher could use as examples of the societal or ethical consequences of a principle or law. The same strategy can be used in social studies classes to focus attention on the effects of scientific or technological developments on historical events or the science- and technology-related aspects of public policy decisions.

A "short take" can be a challenging question, a powerful analogy, an "instant fact," an example of disagreement among experts in the same field, or an error once generally acknowledged as truth. The criteria for an item's inclusion as a "short take" are:

- It must be short—typically only a few sentences. No preparation time should be required to incorporate these items into the curriculum.
- The item should enhance, not distract from, conventional topics. It should also relate to students' day-to-day experiences or to an issue that appeals to an adolescent's imagination and curiosity.
- It should provoke thought and discussion, leading naturally to making some choice or judgment.
- If the item poses a question, responses should be within the scope of students' knowledge. If library research is needed, the item is too time demanding.

A few examples of the "short takes" strategy are provided below.

World Geography

Areas of the ocean floor far beyond national boundaries are covered with valuable deposits of copper, manganese, nickel, and cobalt. As international territory, the oceans are not owned by any particular country. Yet only the developed nations have the money and technology to harvest this wealth. Should the metals be harvested at all? Do poorer nations have any claim to the resources? If so, how are the rights of these nations to be protected?

U.S. History

Defoliants used in Vietnam have now been shown to have had serious harmful effects on the health of U.S. service people exposed to them. Who should be responsible for deciding whether particular chemicals can be used in warfare? How could the safety of American service people be protected without jeopardizing secrecy?

Government/Civics

A new drug for use in treating AIDS is being tested on animals. The results are promising. However, the drug has not yet been approved for testing on humans because of possible harmful side- effects. Should an AIDS patient, who is almost surely going to die anyway, be allowed to volunteer for testing of an unproven drug with possible harmful side-effects? Why or why not?

Source: Adapted from "Short Takes: Science in Society," by C. Arthur Compton, *The Science Teacher* (September 1983), pp. 30-33. Reprinted by permission of the National Science Teachers Association.

2. MOBILES IN THE CLASSROOM

Quotes can stimulate student interest in a subject that is not immediately intriguing, especially if the quotes are funny. One way to spark students to think about STS issues is by making (or having them make) mobiles of quotes about a particular STS issue and then using the quotes in a variety of ways. For example, you can simply leave the mobiles up in the classroom and discuss them as students ask about them. Usually, one student will ask a question about a particular quotation and that will lead other students to ask questions.

You can also have each student pick a mobile for which he/she will write an explanation. Students should be given time (one week) to write these explanations, allowing them to do additional research if they wish. This strategy can be used as a nonthreatening evaluation tool for a unit on a particular STS issue.

Students can find other quotes or make up their own. These can be made into mobiles and added to the ones already displayed. If mobiles are not appropriate for some reason, quotes can be displayed on mini-banners (perhaps computer-generated) or a graffiti board.

The following are examples of quotes for a unit focusing on population:

- ZPG is like hitch-hiking; you know you'll get there, the only question is when and how.
- 1 + 1 ≠ 2 in many families
- What makes you different from anybody else? It's probably the genes you're wearing.
- Spaceship earth—a finite system.
- Population explosion - fact
- Population crisis - opinion
- Quality vs. quantity—a crucial concern.
- Will the stork pass the plow?
- Will the baby boom boom?
- There are so many people in the world that God cannot appear to them except in the form of food.
- Growth for growth's sake is the philosophy of the cancer cell.

Source: Adapted from *Teaching About Population Issues* (Denver, CO: Center for Teaching International Relations, 1983). Reprinted by permission of the publisher. Activity developed by George Otero.

3. STS SCAVENGER HUNT

Scavenger hunts can be used to stimulate interest in a topic, as well as to demonstrate to students how widespread the influence of a particular scientific or technological development is. Scavenger hunts work best if students work in groups of from three to five. Before setting out on the hunt, students should be acquainted with the basic rules: If it belongs to someone else, you must get permission to take it. Be sure to find out if the object must be returned. If so, be sure to return it!

The scavenger hunt should consist of a list of items related to a particular topic. Students are to find as many of the items or pictures of the items as they can within a given time period. For example, before beginning a unit on the benefits and costs of space travel, you might compile a list of everyday items developed as spin-offs from the U.S. space program. These might include the following items:

- Survival blankets, tanning blankets, or home insulation of metallized mylor
- Electronic watch or home computer using a microchip
- Cable TV listings or picture of a satellite dish (representing NASA satellites)
- Any item with Velcro
- Heart monitor
- Improved bowling balls
- Antifogging spray

As an alternative, the hunt could ask for signatures of people with specified characteristics. For example, the list below could be used for a scavenger hunt on biomedical technology:

- A person who carries an organ donor card
- A person who has protested use of animals in medical research
- A person who works in the health care industry
- A person who has written a living will
- A person who supports surrogate motherhood
- A person who knows someone who was kept alive on a respirator

A similar list could be developed for nearly any STS issue.

4. THE TECHNOLOGY TREE

Introduction:

Arthur C. Clarke's famous statement, that any sufficiently advanced technology is indistinguishable from magic, presents us with a double-edged sword (or perhaps a double-sided floppy). It evokes the wonder of new controls over natural processes. It also evokes the specter of people so awed by technology that they willingly suspend their disbelief in magic. If people assume that they cannot understand technology, they abrogate their ability to make decisions about it, to control it.

This lesson is designed to help explore the familiar, inescapable connections that every technology, regardless how exotic, possesses. Making connections visible helps demystify the complex, while also illuminating the necessity for reasoned analysis and critical decision making.

Objectives: Students will be able to:

1. Suggest technological systems and social systems affected by development of particular technologies.

2. List changes resulting from particular technologies.

3. Use a graphic representation to show interconnections among a technology, society, and social change.

4. Recognize the value of understanding these connections in thinking about new technologies.

Subject/Grade Level: Any social studies or science course; especially appropriate for U.S. history/grade 11

Time Required: 1-2 class periods

Materials and Preparation: Make an overhead of the sample technology tree, or copy it onto the chalkboard. Review the example so you can discuss it with students. Prepare copies of Handout 4-1 for the class.

Procedures:

1. Open the discussion with the statements from Victor Ferkiss provided at the top of Handout 4-1. These may be read, written on the board, or made into an overhead. Allow time for students to absorb the statements, then begin to question them for understanding. Students should be able to supply examples to illustrate their agreement or disagreement with any/all of the statements.

2. Display the sample technology tree. Explain that it provides a graphic representation of the interconnections of a technology (the automobile), society, and social change. Discuss the example with the class.

3. Distribute Handout 4-1. Go over the directions with students and have them begin work. Textbooks, newspapers, or weekly newsmagazines may help provide ideas. Some classes may benefit by working in groups. If class discussion has been animated, the handout can easily be assigned as homework.

4. Debrief by having selected students present their work. In the debriefing, consider these questions:

- How would we categorize the technologies selected by the students?
- How many revolve around information technologies?

- What evidence is there that shows this is an area of increasing concern in our society?
- How can seeing connections help us understand new technologies?
- How can examining the connections between science, technology, and society today help us in the future?

5. As an alternative debriefing strategy if the class worked in groups, collect a chart from each group. Then ask each group to do a second chart based on the technology selected by another group. Compare the charts drawn by the two groups, having students discuss the similarities and differences.

Evaluation:

As an evaluation exercise, each student might read and comment on one other student's chart. Comments could include adding more interconnected systems and changes, as well as a personal assessment of how seeing the connections laid out in this manner might affect the student's view of the particular technology.

Extension/Enrichment:

Students may want to explore the technological and social systems surrounding a newly emerging technology (e.g., super conductivity). Their predictions of social changes resulting from the use of that technology could be presented as skits, video plays, or posters.

Resources:

Burke, James, *Connections* (Boston, MA: Little, Brown, 1978).

Ferkiss, Victor, "Technology and the Future: Ethical Problems of the Decades Ahead," in *Futures Research Quarterly*, Volume 2, Number 4 (Winter 1986), pp. 17-30.

You, Me, and Technology, videotape series (Bloomington, IN: Agency for Instructional Technology, 1986-1988).

SAMPLE TECHNOLOGY TREE

No technology exists in isolation.
Individual technologies are part of technological systems.
Technological systems exist in social contexts.
Technological systems modify the societies in which they exist.

Victor Ferkiss

Directions: Fill in the first blank on the left with an existing technology. In the column headed "Technological System," fill in branch technologies that are intertwined with the stem technology. "Social Systems" are people-oriented systems that are interwoven with the stem and branch technologies. Finally, list at least ten changes in society that resulted from the development of the stem technology.

Stem Technology	**Branch** Technological System	**Branch** Social System	**Fruit** Changes Resulting From the Technology
	Road Engineering	Sales People	Increased mobility and speed
	metal/alloy production	Driver Licensing	Drunk Driving Deaths
	Plastics	Advertising	Family Conflict over car use
	Petroleum	Parking Spaces	Live farther from work
Automobile	Repair Networks	Insurance Systems	Easy movement of goods
	Rubber Production	Road Route Selection Process	Travel farther for vacations
	Paint Technologies	Pollution Effects/Control	Hectic pace of life
	Glass	Safety	Mass Transportion in Poor Shape
	Electronics	Delivery Networks	Health risks higher due to pollution
	Textiles	Financing Systems	Greater privacy
	Radio Engineering	Physical Communications	High employment while the industry grew.

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SAMPLE TECHNOLOGY TREE

No technology exists in isolation.
Individual technologies are part of technological systems.
Technological systems exist in social contexts.
Technological systems modify the societies in which they exist.

Victor Ferkiss

Directions: Fill in the first blank on the left with an existing technology. In the column headed "Technological System," fill in branch technologies that are intertwined with the stem technology. "Social Systems" are people-oriented systems that are interwoven with the stem and branch technologies. Finally, list at least ten changes in society that resulted from the development of the stem technology.

Stem Technology	**Branch** Technological System	**Branch** Social System	**Fruit** Changes Resulting From the Technology

5. KNOWLEDGE, SKILLS, AND ATTITUDES FOR THE YEAR 2000

Introduction:

In a rapidly changing and increasingly interdependent world, educators are being forced to make critical and difficult decisions as to what should be taught to prepare students for the world of today and the world of tomorrow. The purpose of this lesson is to seek students' opinions as to what knowledge, skills, and attitudes need to be taught in today's schools.

This lesson is particularly valuable for teachers who want to know what students think is important. Too often, decisions about curriculum are made without student input, and all involved necessarily suffer. Teachers who choose to complete this activity should also be prepared to initiate change, if change can lead to a more productive and constructive classroom.

Objectives: Students will be able to:

1. List important educational goals (knowledge, skills, attitudes).

2. Evaluate the educational program or system responsible for delivering his/her education.

3. Determine personal areas of interest, [illegible]ength, weakness, and responsibility.

4. Recognize the value of knowledge, skills, and attitudes in preparing for the world of the future.

Subject/Grade Level: Any secondary social studies or science course

Time Required: 2 class periods

Materials and Preparation: Make copies of Handout 5-1 for all students. Make sure you have plenty of posting paper, markers, and tape on hand.

Procedures:

1. Distribute Handout 5-1. Ask students to complete the survey by reading each statement and noting their responses in the columns on the right side of the page.

2. When students have completed the survey, select four to six of the survey items and ask for a show of hands for the two responses. For those items where disagreements occur, ask students for their reasons for choosing one response or the other, thereby generating discussion on the item.

3. Following discussion of a few of the items, ask students to write down how old they will be in the year 2000. Ask students what they feel they will have to know, be able to do, and believe in order to successfully live in the year 2000.

4. Divide students into groups of four or five. Assign each group one of the major topics: knowledge, skills, or attitudes. Ask each group to brainstorm a list of items that they feel they will have to know, do, or believe in order to live successfully in the year 2000. Ask one student in each group to list the responses on a piece of poster paper.

5. Following the brainstorms, ask each group to post its responses and to read them to the rest of the group. Allow for clarification questions; seek additions to each of the three lists.

Source: *Teaching About the Future: Tools, Topics, and Issues*, by John D. Haas and others (Boulder, CO: Social Science Education Consortium, 1987).

6. With the assistance of the students, categorize the lists into knowledge items, skill items, and attitude/value items. Ask students to make a copy of the lists for themselves. Once students have the categorized list, ask them to evaluate the list in two ways:

- Ask students to review each item and mark it S (strong) or W (weak) to indicate their own level of competency.
- Ask students to review each item and assign a Y (yes) or N (no) to indicate whether the item is part of the present teaching/learning process as they know it.

7. Discuss the results with the class. Be prepared to offer suggestions for solving individual student and/or program problems.

Evaluation:

Have each student write one suggestion for improving your class or school. Students should explain how their suggestions would help address the future needs of today's young people.

Extension/Enrichment:

1. Interested students might poll school staff members as to the knowledge, skills, and attitudes that should be taught in today's schools. Are their responses similar to those students gave? Why or why not?

2. Have pairs of students choose items for the handout and research what futurists have said about these predictions. Each pair could make a poster presenting the results of their research.

Resources:

Barney, Gerald O., *The Global 2000 Report to the President* (New York: Penguin Books, 1980).

Fuller, R. Buckminster, *Critical Path* (New York: St. Martin's Press, 1981).

O'Neill, Gerard K., *2081: A Hopeful View of Human Future* (New York: Simon and Schuster, 1982).

Salk, Jonas, and Jonathon Salk, *World Population and Human Values: A New Reality* (New York: Harper and Row, 1981).

FORECASTS FOR THE YEAR 2000

Each statement below describes a possible condition in the year 2000. For each statement, mark the right column indicating whether you think it will or will not happen.

		Will Happen	Will not Happen
1.	The present world population of 4.7 billion will have increased by at least 50 percent; world population will be more than 6 billion.	_____	_____
2.	The present U.S. population of 230 million will have increased much more slowly than the population of the world; U.S. population will not be more than 260 million.	_____	_____
3.	Population will have grown faster than the ability to produce food; in some parts of the world, millions will be dying of hunger.	_____	_____
4.	American per capita income will have doubled from $10,500 in 1981 to $21,000 (in 1981 dollars).	_____	_____
5.	Per capita income in the developing nations will have doubled, from $300 to $600.	_____	_____
6.	Many of the countries that were still "developing" in the 1980s will have industrialized.	_____	_____
7.	Air and water pollution levels throughout the world will be high because nations industrializing and modernizing agriculture could not afford pollution controls.	_____	_____
8.	Global reserves of many important nonrenewable natural resources such as petroleum, natural gas, aluminum, copper, lead, and tin will be almost exhausted.	_____	_____
9.	Nuclear power will be supplying at least one-half of U.S. energy requirements and will be expanding.	_____	_____
10.	Several serious accidents involving radioactive contamination of the surrounding areas will have occurred at nuclear power stations.	_____	_____
11.	Almost all nations will possess nuclear weapons.	_____	_____

6. REACTION STATEMENTS WARM-UP

Introduction:

One sure way to interest students in STS is to give them an opportunity to discuss and defend their personal opinions and values regarding current science and social issues. This activity will stimulate a great deal of discussion and raise many topics that can be addressed in study units that follow this introduction to science and society issues.

Objectives: Students will be able to:

1. List a variety of current science and society issues.

2. Discuss and defend their positions on these issues.

3. Respect diverse opinions on these complex issues.

Subject/Grade Level: Any secondary social studies or science course

Time Required: 1 class period

Materials and Preparation: Make copies of Handout 6-1 for all students.

Procedures:

1. Distribute the handout. Explain that students are to read each item, then decide whether they agree or disagree with the statement. They should also think about the reasons for their positions.

2. When students are finished, they are to pair up and compare answers. For each statement where the positions differ, students must try to convince their partner to change his/her mind. If time allows, let discussion continue until the pair is in agreement on as many items as possible. If time is limited, set a maximum time, perhaps ten minutes.

3. As pairs reach agreement, they should join with other pairs of students and repeat the discussion process with the new groups of four.

4. Continue this doubling up process until the class is in two large groups. Allow a few minutes for discussion in these large groups and then call the class to attention. Go through the items one at a time to gauge student positions. Ask individual students to explain their reasoning for each item. How do these issues and positions reflect/affect our society? World society? What are the "right" answers? How do we find them?

Evaluation:

By circulating through the groups during the discussion, you can evaluate students' level of participation and their ability to support their positions. As a further evaluation tool, ask each student to pick one of the items on which there was disagreement in the initial pair and list the arguments on both sides of the issue.

Extension/Enrichment:

Encourage students to begin an STS notebook or journal, using one of the statements from the worksheet as a springboard for their first entries.

REACTION STATEMENTS WORKSHEET

Check whether you agree or disagree with each of the following statements. Think carefully about why you feel the way you do. When you have finished, find another student who has finished and compare answers. Discuss your answers and try to reach agreement on each of the items. Try to convince your partner of the correctness of your own position, but also listen carefully to your partner's ideas.

Agree	Disagree	
_____	_____	1. Disease, abortion, wars, murder, famine, accidents, and pollution REDUCE the world's population; its INCREASE is promoted by parenthood, medicine, public health, peace, law and order, scientific agriculture, accident prevention, and clean air. Therefore, the population explosion is desirable.
_____	_____	2. Every day there are 150,000 more people in the world than there were the day before. This affects you.
_____	_____	3. The United States should develop a supersonic transport plane (SST)—a commercial plane that goes faster than the speed of sound—to compete with the Soviets and the Europeans, whose SSTs are now in commercial use.
_____	_____	4. High school football, power mowers, and mountain climbing take more lives each year than nuclear power plants. Therefore, they should be abolished before nuclear power plants are.
_____	_____	5. No money should be spent trying to wipe out the Med fly, gypsy moth, or other pests that are unusually numerous in a particular year.
_____	_____	6. Putting fluoride in the public drinking water reduces cavities in your teeth, but it is medication without your consent and should therefore be stopped.
_____	_____	7. The rich coal beds that underlie some of the most fertile wheat-growing land in the American west should be strip mined.
_____	_____	8. There should be laws against (a) trail bikes and dune buggies on public lands because they destroy fragile plants and the peace and quiet and (b) loud motorcycles on public highways.
_____	_____	9. Science will solve such social problems as crime, hunger, and mental illness.
_____	_____	10. Members of Congress should be required to show that they have had (and passed) some high-school-level science courses before they take office.

7. TRIVIALIZED TECHNOLOGY

Introduction:

The United States has often been portrayed as "technology-happy." To solve problems, Americans devise a technology, a machine, or a system. This application of "Yankee Ingenuity" has reached an apex in the class of people known as "YUPPIES"—Young, Urban Professionals. These highly skilled, highly educated, highly paid people are commonly depicted as immersed in the various leisure-oriented technologies their wealth can purchase.

This lesson involves students in analyzing this viewpoint through interpreting a cartoon and drawing one of their own.

Objectives: Students will be able to:

1. Define materialism and list some of its effects.

2. Interpret a cartoon.

3. Take a position on international production and consumption and convey that position through a cartoon.

4. Recognize that more technology is not necessarily better.

Subject/Grade Level: U.S. history/grade 11; current events/grades 9-12; sociology/grade 12; economics/grade 12; any secondary science course

Time Required: 1 class period

Materials and Preparation: Make copies of Handout 7-1 for all students. Gather a collection of catalogs and newspaper advertisements (optional).

Procedures:

1. Pass out the cartoon and allow time for students to read it.

2. Discuss the cartoon, its assumptions, and its implications. Consider these questions:
   - Is this cartoon funny? Sad? Grim? Why?
   - Define "materialism."
   - Define "abstract materialism." (Cathy provides one definition.)
   - How does consumption by individuals relate to/affect national economies?
   - How might a person from a "Third World" country react to this cartoon? Would it be funny to them?
   - If Americans are primarily consumers, who/where are the producers? Which of these items were probably made in the United States? What is the net global economic effect? How is the American balance of trade problem a global problem, too?

3. Have students draw their own cartoons addressing the issue of international production and consumption. Students may take any position on international trade, but their positions must be clear in the cartoon. The cartoons may be completed as homework.

4. Post cartoons around the room for student comment/reaction.

Evaluation:

Use the following criteria to evaluate the cartoons:

Clarity of position	0-5 points
Humor	0-3 points
Drawing Quality	0-2 points

Extension/Enrichment:

Students might want to pursue the origins of the items listed in the cartoon. Students in lower grades could research the origins and prices of the items, then present them to the class on posters or world maps with connecting lines between product sources and the United States.

Older students might research Rube Goldberg's work or investigate the annual MIT competition in which students design the most complex technology they can imagine for accomplishing simple tasks.

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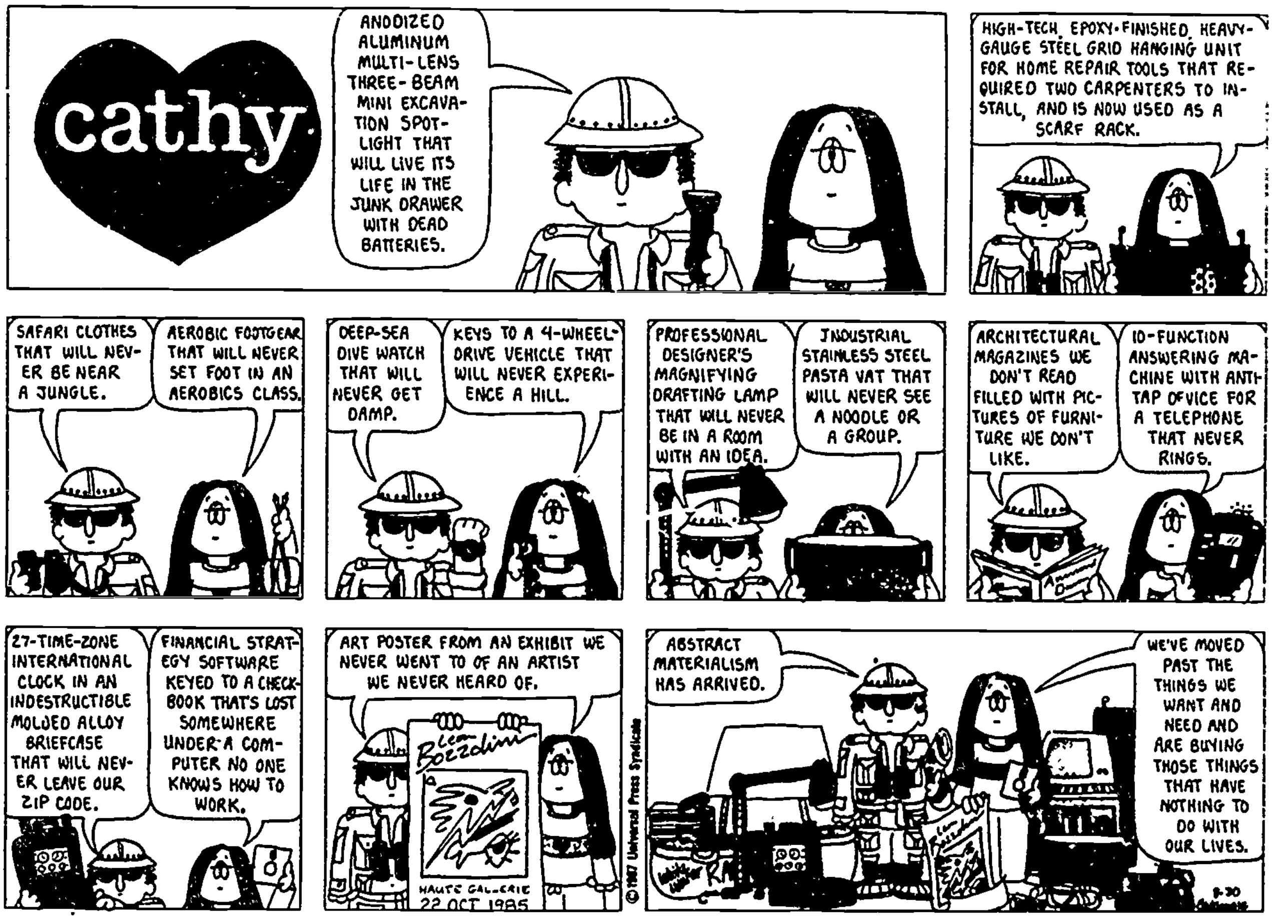
TRIVIAL TECHNOLOGY?



8. SCIENCE AND TECHNOLOGY IN THE NEWS

Introduction:

Most citizens get their information about science and technology from the popular media—newspapers, television, and popular magazines—rather than the scientific press. In this lesson, students analyze the amount of coverage given to news about science and technology in various forms of news media. They examine how the medium affects the coverage given to such issues, and they suggest areas for improvement.

Objectives: Students will be able to:

1. Identify science and technology issues in the news media.

2. Gather data on coverage of science and technology issues in the news media.

3. Compare and contrast coverage in various media.

4. Suggest improvements in news coverage of science and technology issues.

5. Value the role of the press in providing the public with information about issues related to science and technology.

Subject/Grade Level: Any secondary science or social studies course

Time Required: 2 class periods

Materials and Preparation: Check the newspaper and television news programs for several nights prior to using the lesson to compile a list of scientific and technological developments in the news. Make copies of Handout 8-1 for all students.

Procedures:

1. Make a chalkboard list of the scientific and technological developments that have been in the news recently. Poll the students to find out how many are aware of why these developments have made "news" in the past few days.

2. Discuss with students where they get most of their information about science and technology. Do they learn more from newspapers, television, and newsmagazines, or from specialized science publications? Discuss the importance of the popular media in shaping public perceptions of science and technology.

3. Tell students they will be analyzing how the news media cover scientific and technological developments. Divide the class into three groups and distribute copies of Handout 8-1. Assign one group to conduct a content analysis of daily newspapers, the second groups to analyze television news programs, and the third group to analyze weekly newsmagazines. Students should use the analysis instrument for a specific amount of time; one or two weeks is recommended.

4. After the analyses have been completed, ask the students to compare the emphasis the different news media give to science and technology and to speculate why time/space was allocated as it was. Students should also attempt to determine how the technology involved in each medium affects the way news is covered (for example, television focuses on stories that have a strong visual component, has great immediacy, can bring a story to the audience as soon as it happens, etc.). The following questions may be used to summarize the discussion:

- Do the news media take a positive, negative, or balanced view of developments in science and technology?
- How do the news media influence the way the public thinks about science and technology?
- Do the news media show the effects of science and technology on society?
- How would you improve coverage of issues related to science and technology by newspapers? television? newsmagazines?

Evaluation:

Have students individually or with other members of their groups write letters to the editor of one medium suggesting improvements in coverage of science and technology issues or complimenting the editor on coverage given these issues. The letters should address such concerns as balance and depth of coverage.

Extension/Enrichment:

Let students plan their own "newscasts" on science and technology issues. Their programs should address the problems they identified in doing their analyses.

NEWS MEDIA ANALYSIS FORM

Use this form to record the amount of attention devoted to issues related to science and technology by ______________________________ during the period ____________________.

Publication or broadcast date	% of time/space devoted to science/technology	Science/technology issues covered	Was coverage positive, negative, or balanced?	Was the effect of science and technology on society covered?

9. STS IN MY LIFE

Introduction:

This warm-up lesson sets the stage for further activities on the interactions of science, technology, and society. Students may be unaware of the degree of interconnections between these three aspects of society and the high degree of dependence our society has on the products of science and technology.

Objectives: Students will be able to:

1. Describe one way in which they depend on technology in their everyday lives.

2. Make inferences about the level of dependence on technology in our society on the basis of the example analyzed.

3. Formulate a position on whether dependence on technology is desirable or not.

Subject/Grade Level: Any secondary social studies or science course

Time Required: 1/2 class period

Materials and Preparation: None

Procedures:

1. Read the following instructions to students and allow them 2-3 minutes to think.
   - Look around the room. Look at each other and yourselves. Examine the clothing you are wearing. How many of the items you are wearing could you exactly duplicate at home? That includes making the fabric and other materials, as well as making the clothing items.
2. Discuss their responses for a few minutes, then ask these extensions of the question:
   - What things would be most useful in trying to copy the fabrics? Is it possible to duplicate them at home? If you used all of the resources available at your school, would it help? At your parents' work places? What is the limiting factor? (Exactly what is it that would keep us from duplicating these things if we wanted to?)
   - How does this compare to the types of clothing we would wear if we lived in central Africa? Antarctica? In the year 1900? 1700? 500 B.C.?
   - What does this say about our society's dependence on science and technology? Do you think such great dependence on technology is good? What weaknesses might technological societies have because of that high degree of dependence?

3. Encourage students to express their opinions freely. Probe for factual examples to support their positions.

Evaluation:

The discussions should lead easily into brief essay-writing exercises or development of posters that illustrate points made. These products could be used for evaluation purposes.

Extension/Enrichment:

1. Have students use the same procedure to analyze their dependence on technology in another area of their lives, such as food or shelter.

2. You might encourage students to conduct the same discussion with their family members. Did parents have a different view on the desirability of depending heavily on technology? If so, what are the reasons for the differences?

10. TEN INVENTIONS THAT CHANGED OUR LIVES

Introduction:

This lesson acts as a discussion starter to introduce students to science, technology, and society issues. The interconnections of these three aspects of culture are explored through a brief reading, a categorizing exercise, discussion, and a webbing chart. Throughout the exercise, students should be encouraged to examine their opinions for deeper insights.

Objectives: Students will be able to:

1. Explain the impact of ten innovations on society.

2. Recognize the relationships among these innovations.

3. Give examples of society's role in shaping technology.

4. Interview adults to gather information.

5. Value diverse opinions about the importance of particular technologies.

Subject/Grade Level: Any social studies or science course/grades 9-12

Time Required: 2-3 class periods

Materials and Preparation: Prepare copies of Handouts 10-1, 10-2, and 10-3 for all students. You may want to make overheads of the STS chart from Handout 10-2 and the webbing chart on Handout 10-3. The best preparation for this exercise is for teachers to work through it themselves. Teachers should note areas where they can provide extra, analogous examples to illustrate the interconnections.

Procedures:

1. Distribute Handouts 10-1 and 10-2 and allow 25-30 minutes for reading and work. (This assignment could be done in small groups.)

2. Begin the debriefing. Since this is primarily a discussion starter exercise to sensitize students to STS topics, student thought and opinion are of primary importance. The "correct answers" are those answers that demonstrate logic, perception, and the persuasive use of evidence.

3. The categorizing exercise (question 1) will probably be frustrating for students because of the difficulty of assigning some items to only one category. Force them to make a choice even though the categories are too rigid and exclusionary. Redirect student opinions/objections back to other members of the class for analysis.

4. Complete the debriefing through Question 6. Write the following homework assignment on the board:

Write a paragraph containing at least five sentences. The paragraph should explain how society directs changes in science and technology. To better understand how society can have that effect on science and technology, you will need to interview your parents or several other adults. In your paragraph use one of the examples they suggest to illustrate that relationship. You must include one quotation from an interview in your paragraph. This assignment is due: ________________.

5. Pass out Handout 10-3. This exercise is somewhat repetitive, but it gives a different slant on the information and extends the discussion of the interaction of science and society. Allow 10-15 minutes for the webbing, then begin the debriefing. Stress ways that society might direct the development of

certain types of science over others and how that in turn influences the directions society takes. That discussion will better illuminate the homework assignment students should have begun the night before.

6. Check for understanding and review the homework assignment.

7. On the due date, collect the homework. Allow 15 minutes for a discussion of the homework topic and the input students obtained from their parents. Discuss the examples students used in their papers.

Evaluation:

Judge the homework papers for how accurately students followed directions and for how clearly they demonstrated the directive nature of society on the scientific example they selected.

Extension/Enrichment:

Have students work in small groups to brainstorm a list of how "today's problems reflect yesterday's successes." What kinds of problems could be created by today's technological successes?

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THE CONSUMER HIT PARADE

In the October 6, 1987, issue of *Newsweek*, Robert J. Samuelson described the ten products or services that he believed had changed post-war American society most profoundly, resulting in a "society of greater individual choice and mobility without many of history's wants and discomforts."

Samuelson's list included the following ten items:

- Television: "TV has surely changed politics; it brought the Vietnam War into living rooms. It's also expanded national culture..."
- Jet Travel: "It has shrunk the country."
- The Pill: "Along with working women and better appliances—subverted old sex roles."
- Air Conditioning: "It made the sun belt possible."
- Automatic washers and dryers: "They revolutionized housework."
- Antibiotics: "Drastically reduced the threat to life of commonplace injuries and infections."
- Health Insurance: "It made health care an entitlement."
- Long Distance: "It too has shrunk America."
- Social Security and Pensions: They made retirement "an expected part of life."
- Interstate Highways: "They've shaped suburbia by attracting offices, malls, and industrial parks, determining where we live, work, and shop."

Samuelson's list did not include computers. He described computers as one of the products "that mainly serve business" and therefore "don't count."

We often forget just how much society has changed. The consumer culture's emphasis on the "new" tends to keep us from focusing on the impact of change.

TEN INVENTIONS THAT HAVE CHANGED OUR LIVES

Directions: Skim over the questions below. Then read "The Consumer Hit Parade." Answer the questions and be prepared to explain the reasoning behind your answers.

1. Place each of Samuelson's "Consumer Hits" into one of these categories:

Science	Technology	Society

2. Explain why you agree or disagree with Samuelson's decision to omit computers from the list.

3. What items missing from Samuelson's list do you feel should be included?

4. Which items do you think he should have omitted?

5. For each "Consumer Hit," identify one scientific discovery that laid the groundwork for the development of that item.

1)

2)

3)

4)

5)

6)

7)

8)

9)

10)

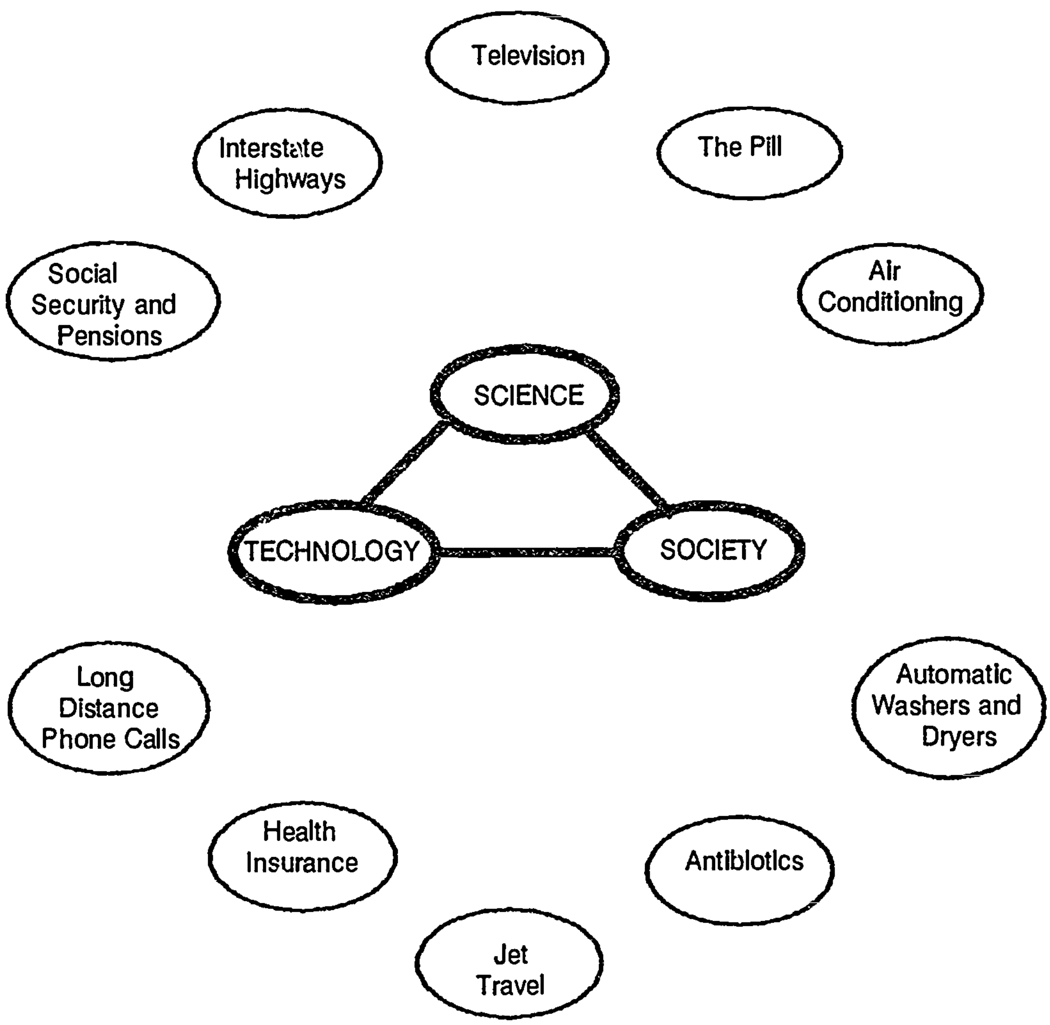
6. Pick one of the items and list one positive and one negative effect that item has had on society. Be prepared to explain your examples.

THE WEB OF SCIENCE, TECHNOLOGY, AND SOCIETY

Was categorizing items as science, technology, or society difficult? All of the "consumer hits" are connected to more than one category.

1. Draw a line from each consumer item to the categories you feel are directly connected to it.

2. With a different type of line or a different color pen, connect all of the consumer items that you feel are related or have mutual interactions.



11. BUMPER STICKER POSITION STATEMENTS

Introduction:

This activity is designed to help students identify technological issues and express their opinions on those issues. This is a good introductory exercise for a science, technology, and society unit.

Objectives: Students will be able to:

1. Identify current technology issues.

2. Express a point of view on a technological issue.

3. Explore the implications of their viewpoints.

Subject/Grade Level: Any secondary social studies or science course

Time Required: 1-2 class periods

Materials and Preparation: For each student, you will need two or three bumper-sticker-sized strips of poster paper and markers. You will also need a variety of current newspapers and newsmagazines.

Procedures:

1. Lead students in a brainstorm to list contemporary technological issues. Post all students' suggestions on the chalkboard.

2. Have students design and write their own bumper stickers dealing with contemporary issues with technological implications. Examples: "Recycle Yourself: Sign A Kidney Donor Card" (Transplants), "H_2O: If You Can Read This, Thank Your Science Teacher" (Importance of Science and Education), "I Took A Stand To Save The Land" (Land Use). Let students look in newspapers and magazines for ideas.

3. Have students write letters to bumper sticker companies explaining why their proposed product addresses an important view on a current issue. You may allow some research time for this portion of the activity if you wish.

4. Have students present their work to the class. Discuss the issues and allow students to formulate their own views.

Evaluation:

Evaluate the students' work on the basis of (1) creativity and (2) how well students justified their positions.

Extension/Enrichment:

Have students create a bulletin board display of their bumper stickers, preferably where students from other classes can view it.

Source: Adapted from *Turning the Tide. Technology Infusion Project* (Harrisburg, PA. Pennsylvania Department of Education, 1984), pp. 12-13. Used by permission of the Pennsylvania Department of Education.

4. MODEL LESSONS ON STS ISSUES

12. WORLD POPULATION GROWTH

Introduction:

Developing humane and effective approaches to problems associated with population growth requires a solid understanding of the mathematics of that growth. This lesson introduces basic population concepts through simple simulations and graph interpretation.

Objectives: Students will be able to:

1. Define and give examples of exponential and linear growth.

2. Explain that population grows exponentially.

3. Calculate doubling time.

4. Appreciate the complexity of issues related to population growth.

Subject/Grade Level: World geography or history/grades 7, 10; sociology/grade 12; current events/grades 10-12; environmental studies/grades 9-10; biology/grade 10

Time Required: 2 class periods

Materials and Preparation: Make copies of Handout 12-1 for all students; also make transparencies of the chart and two graphs provided at the end of the lesson. For each group of four to six students, you will need eight paper cups, one bowl, and 501 pinto beans. A one-pound bag of pinto beans contains about 1,300 beans, so for a class of 30 you should buy two pounds. Separate the beans into groups of about 500. Count out the first group, add a few extra, then estimate the rest (500 pinto beans are almost one level cup). You will also need a watch or clock with a second hand.

Procedures:

1. Divide the class into groups of four to six. Give each group a bag of at least 501 beans. Give each group eight paper cups and a bowl that is large enough to hold the 501 beans easily. Write this series of numbers on the board in a vertical column: 1, 30, 20, 50, 100, 100, 100, 100. Have each group label their cups with these numbers, then count as many beans into each cup as indicated on the label. While they write and count, post this information on the board:

1 bean = 10 million people
1 minute = 1,000 years
1 second = about 17 years

2. Point out the values on the board. To give perspective, point out that the greater Chicago area has a population of about 8 million; greater Los Angeles, 12.4 million; greater New York City, 17.8 million; the population of the United States is about 240 million. Also relate the size of your town to these numbers.

Source: Reprinted by permission of the publisher from *Population Education: A Knowledge Base*, by Willard J. Jacobson (New York: Teachers College Press, 1979), pp. 34-36.

3. Inform students that this simulation will demonstrate two important population concepts: growth and rate of growth. Have students gather close to their bowls. Arrange the cups of beans into the order shown on the board. Have students pick up the cups and be prepared to pour them into the bowl, one at a time, on your signal. Warn them that the first pourings will be widely spaced, but that the signals to pour will get closer and closer together.

4. Follow the timing on the "Population Growth Chart," using the second hand of a watch or clock for giving the signals to pour. The first and second periods (of 50 hours and 10 minutes) should, of course, be simulated. During those periods, do use some significant amount of time to discuss the estimates of population for these periods, or other topics, so that students see a clear relationship later to the acceleration of growth over time. Proceed with the other periods as shown on the chart.

5. After all the beans have been poured into the bowls, have students reflect on the exercise. Project the "Population Growth Chart" transparency to show students the process they have just simulated. How many beans are there in total? How did the total amount change over time? Describe the rate of growth. Why is the growing number of beans (people) important? Why is the rate of growth important? Have students return the beans to the bags. Collect the cups, beans, and bowls.

6. During the first discussion, students will have observed that the trend in population growth is that of acceleration. That type of trend is called "exponential growth." This contrasts with "linear growth." To illustrate these two concepts, write on the board a linear number series: 1, 2, 3, 4, 5,... Have students note that the increase between steps is the same—1. Next, write out an exponential series: 1, 2, 4, 8, 16, 32,... The increase between each step is a factor of 2 (i.e., each step doubles). Explain that both types of growth involve measuring change over time. Thus, both graphics have time across the horizontal axis. The vertical axis shows the items whose number is being charted over time. The two types of growth can be illustrated by projecting the "Growth Rate Graph" transparency. Elicit other examples of linear and exponential growth from students. That world population growth follows an exponential trend can be illustrated by projecting "The World's Population Growth" transparency.

7. For homework, have students complete Handout 12-1. Be sure students understand the assignment. Point out that the numbers across the bottom are units of time. They can be seconds, minutes, hours, or even centuries. They can also be renumbered to reflect specific years, months, or times of day.

8. The following day, collect the homework. Then spend some time discussing the various linear and exponential series students were able to discover. Linear series could include standing in line for lunch, the progression of periods in the school day, the grading system, etc. Exponential series are more difficult, but could include the number of personal computers over the past 10 years; number of K of memory in personal computers over the past 10 years; number of music videos available in the past 10 years; number of CD's available; etc.

9. Inform students that current trends in population growth can be examined to predict the amount of time it takes for the population to double. Write this on the board:

1% growth per year will double the population in 70 years
1% = 10 new people for every 1,000 people

To calculate the doubling time, divide 70 by the percentage rate of increase:

70 divided by % increase = number of years to double the population

Have students work out this problem:

The world population increase for 1987 was 1.7%. How many years will it take to double the current population of 5 billion?

Answer: 70 divided by 1.7% = about 41.2 years

10. Have students calculate how old they will be in 41 years. World population will be 10 billion if the current trend continues.

11. To illustrate the doubling trend more vividly, push the desks aside so there is room for all the students in the class to stand crowded together as closely as possible in the middle of the room. Quickly draw a chalk circle on the floor around the group. Have students step out of the circle and separate into groups in an exponential series: 1, 2, 4, 8, 16. (This works best with a class of 32 or more, but the idea is apparent even with groups of 16-25.) Start with one student in the circle and double the number of students every minute.

12. Have students straighten the room and return to their seats. How does the simulation illustrate exponential growth? What is one possible outcome of continued exponential growth? What are the option?

Evaluation:

For homework have students do a small creative project that illustrates what they think the world will be like in the year 2030, with a world population of 10 billion plus. Students may write short stories, poems, or essays, or they may make posters or videotapes. Examine these products for evidence that students understand the possible consequences of continued population growth.

Extension/Enrichment:

Have students make projections regarding the converse situation; that is, declining world population. What might cause such a decline (beyond the obvious nuclear war)? What consequences might result?

Resources:

Jacobson, Willard J., *Population Education: A Knowledge Base* (New York: Teachers College Press, 1979).

Population Information Program, Johns Hopkins University, Hampton House, 624 North Broadway, Baltimore, MD 21205.

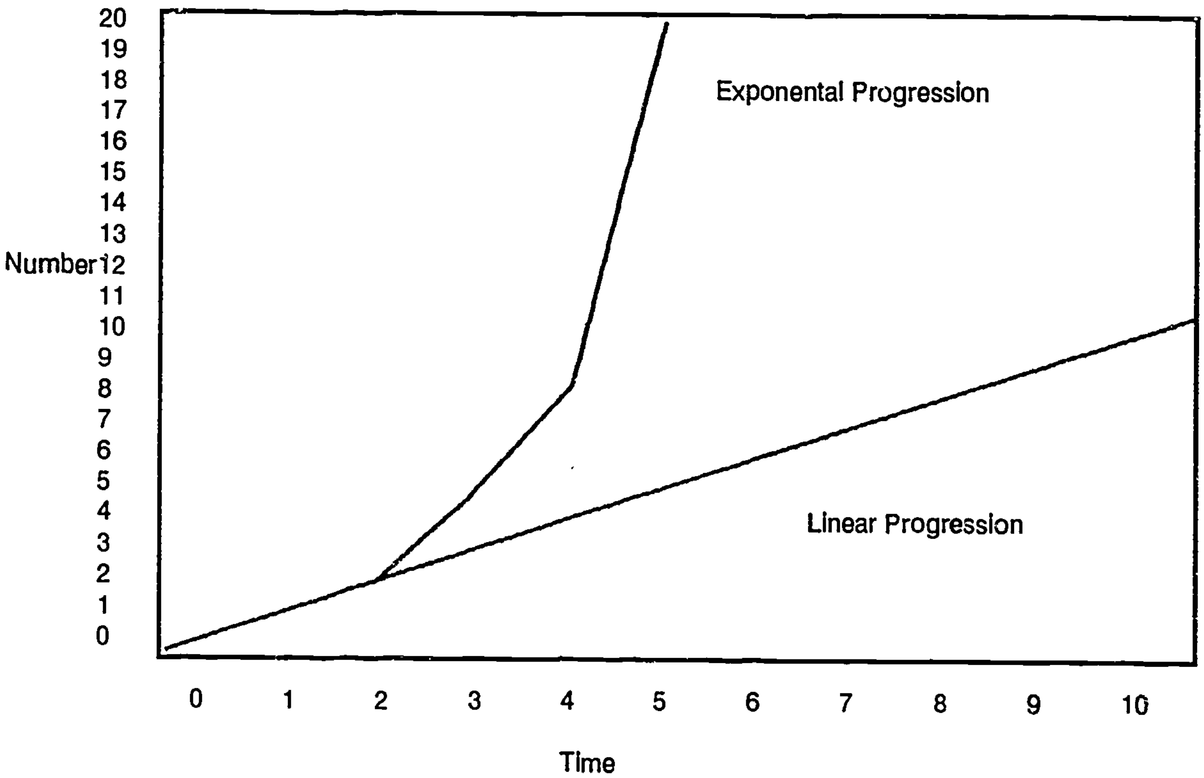
Population Reference Bureau, 2213 M Street, NW, Washington, DC 20037.

United Nations Fund for Population Activities, 1120 19th Street, NW, Washington, DC 20036.

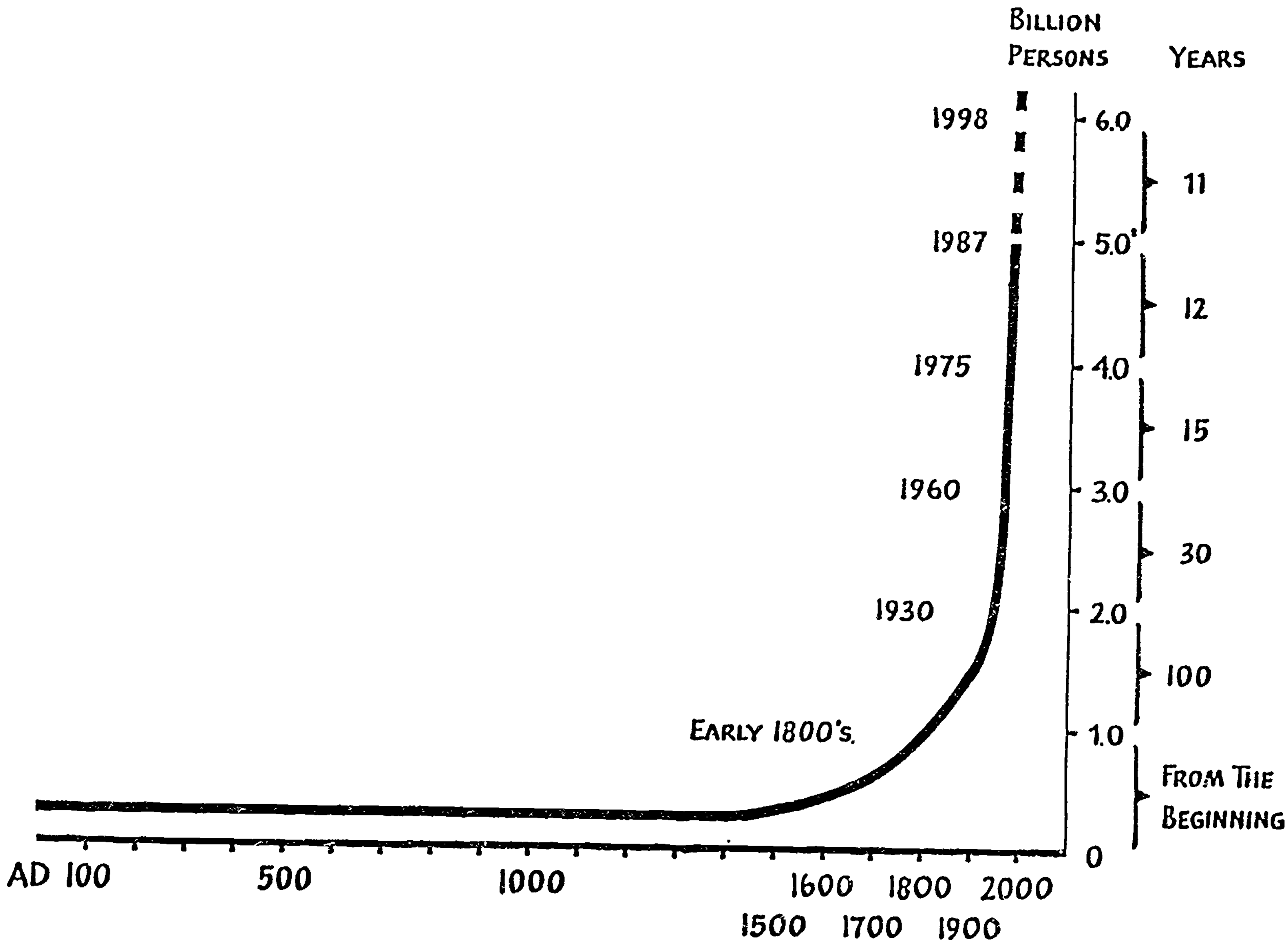
POPULATION GROWTH CHART

Simulated Time Interval	Time Interval in Years	Approximate Date	Beans Added	Population Size
Begin	Origin of Humans?	?	0	Few
50 Hours Later	3,000,000	?	1	10 Million
10 Minutes Later	10,000	1 A.D.	30	300 Million
1 1/2 Minutes Later	1,500	1500 A.D.	20	500 Million
21 Seconds Later	350	1850 A.D.	50	1 Billion
5 Seconds Later	75	1925 A.D.	100	2 Billion
2 Seconds Later	35	1960 A.D.	100	3 Billion
1 Second Later	15	1975 A.D.	100	4 Billion
1 Second Later	11	1986 A.D.	100	5 Billion

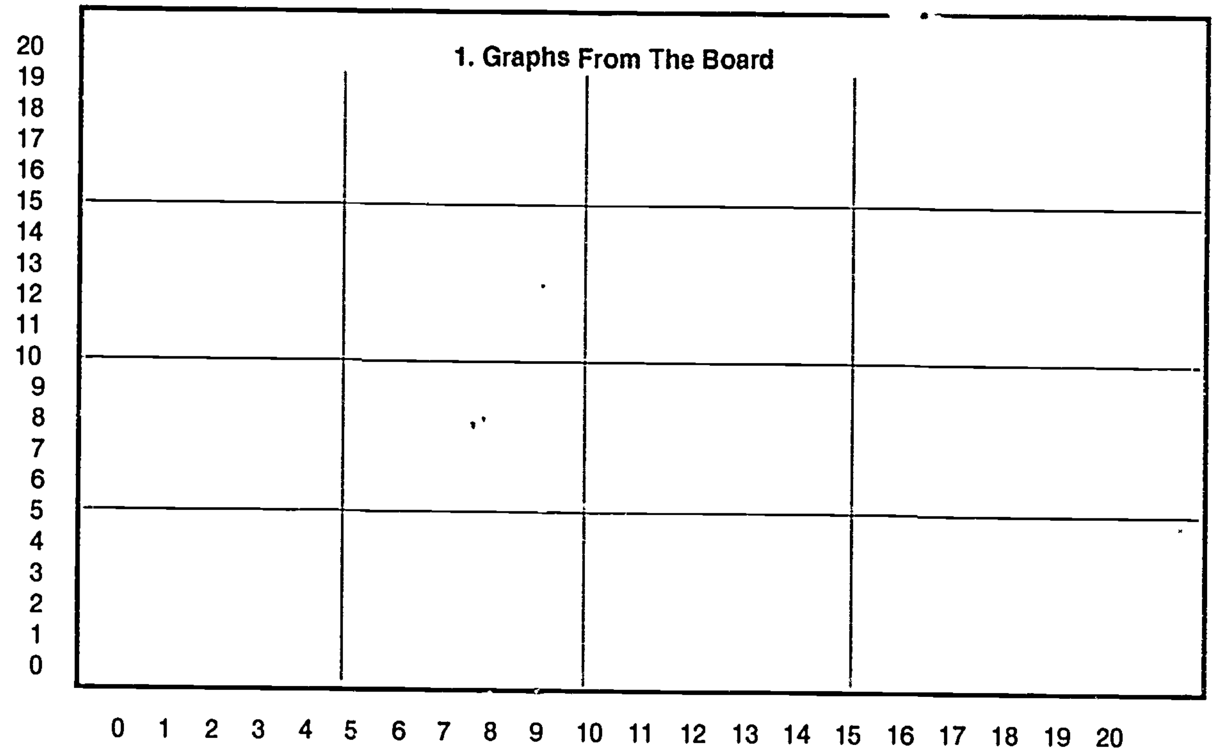
GROWTH RATE GRAPH

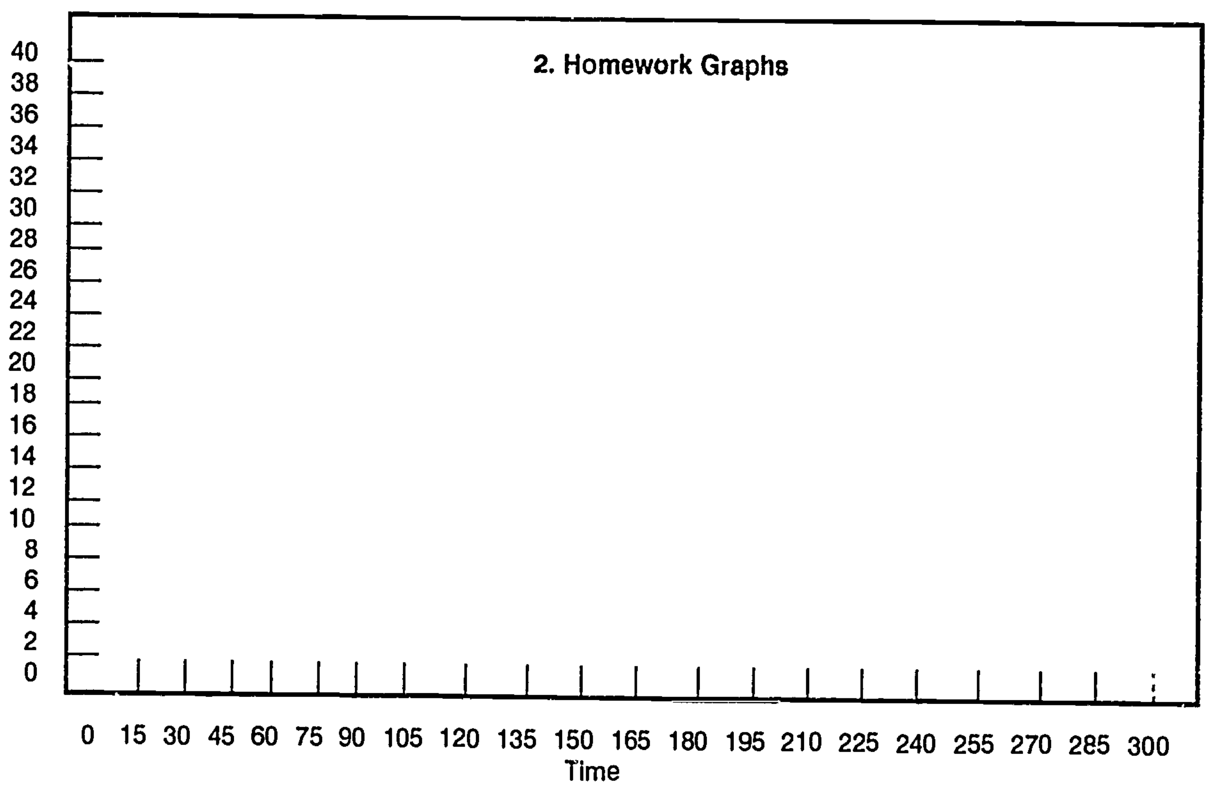


THE WORLD'S POPULATION GROWTH: PAST AND PROJECTED



POPULATION GROWTH WORKSHEET





1. Onto Graph 1, copy the linear growth rate and the exponential growth lines from the example in the "Growth Rate Graph" overhead.
2. Write out a five-number linear series that begins with your age. Graph it on Graph 2.
3. Write out a five-number exponential series that begins with your age. Graph it on Graph 2 also.
4. Describe one common linear series, other than your age.
5. Describe one common exponential series, other than population growth.

13. ENERGY PRODUCTION AND POPULATION

Introduction:

It is difficult to explain precisely why the more developed nations have lower birthrates than the less developed nations. At best we can list some characteristics of nations, compare them to each other and to changes over time, and attempt to correlate some of the observations. R. Buckminster Fuller has connected the rising production of energy to declining birthrates. He draws a secondary causal relationship: the greater availability of electricity does not, in itself, reduce births (that would be a primary causal relationship), but it does change society in ways that result in fewer births.

In this lesson, students examine the evidence presented by Fuller in ways that will enhance their understanding of Fuller's idea while improving graph analysis skills.

Objectives: Students will be able to:

1. Describe the relationship between energy production and birthrates.

2. Cite a possible explanation for the relationship.

3. Read and compare line graphs.

4. Analyze statistical evidence critically.

5. Value the ability to defer judgment until the facts can be assessed.

Subject/Grade Level: World geography or history/grade 10; current events/grades 9-12, general science/grade 9; physical science/grade 8; environmental studies/grades 9-10

Time Required: 4-5 class periods

Materials and Preparation: Review the activities, the graphs, and the student questions; answers for the questions are provided, although some experience with statistics would be helpful throughout the exercise. An entertaining and easy to read book on the subject of misleading statistics in *Lying With Statistics* by Darrell Huff (New York: W.W. Norton and Co., 1954). Make copies of Handouts 13-1, 13-2, and 13-3 for all students.

Procedures:

1. Divide the class into groups of three or four students. Pass out Handouts 13-1 and 13-2 to each student. Have students work together to answer the questions. Caution them that some of the questions require them to think beyond the information given in the graphs. Point out that each student must take and defend a position in question 22.

2. Debrief the questions. (Answers are provided at the end of the teacher material.) During this first debriefing, deal only with the information as it is presented in the graphs. Point out the dramatic crossing of the lines on each graph and the apparent high visual correlation of increasing energy production and falling birth rates. Collect the question sheets to review student answers to question 22. Evaluate the answers based on how well students state and defend their positions.

3. For homework, have students clip out newspaper and magazine articles that include charts or graphs. Each student should collect at least three articles. After they have collected the graphs, they will be doing an analysis of one of them based on the analytical skills they are learning. The final product will be due in several days.

4. Reassemble the small groups and return their copies of Handout 13-2. Have students take out Handout 13-1. Briefly comment on their analysis of the graphs the previous day. Discuss the importance of graphs and statistics in organizing and clarifying information. Point out a couple of articles in current publications that use statistics and charts as the basis for stories (*USA Today* uses many such illustrations).

5. Introduce the idea that statistics can be very subjective, despite the apparent cold precision of numbers. You may wish to expand on this idea by using information from the **Teacher Background Notes** following the lesson. Tell students that they will be working with the graphs again, but on an even more analytical level. Pass out Handout 13-3 and allow students time to complete it. This will take most of a period.

6. Collect Handout 13-3 at the end of the period. Remind students of the homework assignment. Skim through the papers, checking for difficulties with the graphing work.

7. Return Handout 13-3. Debrief the questions. During the debriefing, encourage students to apply their questions to articles or news reports they have been collecting. Remind students of the homework.

8. Review the statistical learning students have acquired. If this is part of a larger population unit, reapply the concepts of modernization and development to population growth. Collect the homework.

Evaluation:

Evaluate the homework based on the following criteria:

- Were at least three items presented?
- Was one item analyzed?
- How well were the concepts of analysis applied?

Extension/Enrichment:

1. Have students conduct research to extend the data to the present or to better establish the process for converting energy production into common units. Using various permutations of the chart of equivalents below, plus data from almanacs, it should be possible for students to approximately replicate the data given, or to expand the time line in either direction.

1 barrel of oil	=	42 U.S. standard gallons
	=	enough energy to heat an average American home to 68 degrees Fahrenheit during four days of freezing weather

6000 barrels of oil =
2,800,000 pounds of bituminous coal =
38,000,000 cubic feet of natural gas =
1 pound of fissionable uranium

Weight conversion—1 pound = .454 kilograms

6,000 barrels = 1,271,200 kilograms of coal
1 barrel = 211.87 kilograms of coal

2. As students perform physical experiments in other units of study, they can be introduced to normal curves. The observations and measurements from their individual experiments can be plotted as a class or with other classes doing the same work. The appearance or nonappearance of a normal curve of recorded observations can then be analyzed for. sources of measurement error, the uses/abuses of statistics; the meaning of "average"; etc.

3. Graph-reading skills can also be applied to analyzing more critically charts presented in textbooks.

Answers to Handout 13-1

1. Birthrate per Thousand People

2. Energy Production: Kilograms Coal Equivalent Per Capita

3. Years

4. The number of live births there are for every 1,000 people in that country.

5. All types of energy production (coal, natural gas, petroleum, geothermal, hydro-electric, nuclear) have been converted into a single measure so that the total output can be more accurately compared. Those converted units are then divided by the number of people in the nation being examined to give a per capita figure. See the **Teacher Background Information.**

6. 1957—37; 1969—34; 1977—30.

7. 1957—1262; 1969—1750-1775 approx.; 1979—1971.

8. The trend is increasing production, with some slowing after 1973.

9. The trend shows a decreasing birthrate.

10. Spain

11. Slowly decreasing birthrate.

12. Increasing energy production, with rapid increase after 1965.

13. The birthrate is not decreasing at as fast a rate, but energy production is increasing more quickly than the world rate.

14. Generally, yes.

15. The graphs seem to show that when energy production per capita increases, birthrates decrease. This is the central relationship suggested by the graphs and is the central focus of the exercise. Students will be evaluating the evidence presented to determine the strength of the relationship.

16. These answers will vary. Have students justify their conjectures. Possibilities include: Spain—example of a less rich European nation; interesting rise in energy production; the authors only speak Spanish; when energy production increases rapidly in 1965, birthrate drops more dramatically. El Salvador—Third World nation; a more ragged trend, but one that still shows the relationship nicely; current American concern with that nation, etc.

17. Answers will vary. Possibilities include: They don't; energy production requires great organizational skills that can only be supplied and maintained by strong political organizations, etc.

18. Exploration/exploitation of new oil fields; expansion of nuclear power, geothermal power, tidal power, biopower, and solar power.

19. This becomes an important question as students explore the possible connections between energy production and birthrates. Possibilities include: electricity provides TV and other entertainment alternatives to sex; better health facilities help insure the survival of children, so fewer births are neces-

sary to resupply the labor force; more schools can be built so kids can learn more about how to use/control electricity and about birth control. The possibilities are endless.

20. Increase the amount of energy available to people and birthrates will fall. The general suggestion is that when the standard of living is raised, birthrates fall. This idea should be the basis of interesting and heated discussion for students.

21. Should be very effective on the basis of the information provided here.

22. Answers will vary.

Answers to Handout 13-2

1. Energy Production: Kilograms Coal Equivalent per Capita.

2. 1000; 2000.

3. 7000; 100; 12000; 250.

4. U.S.S.R.; Spain: answers will vary. The overall effect is that the relationship is less strong than suggested in the original graphs.

5. Answers will vary. Generally, groups supporting the "increased standard of living" approach to population control; utility companies; development bankers, etc.

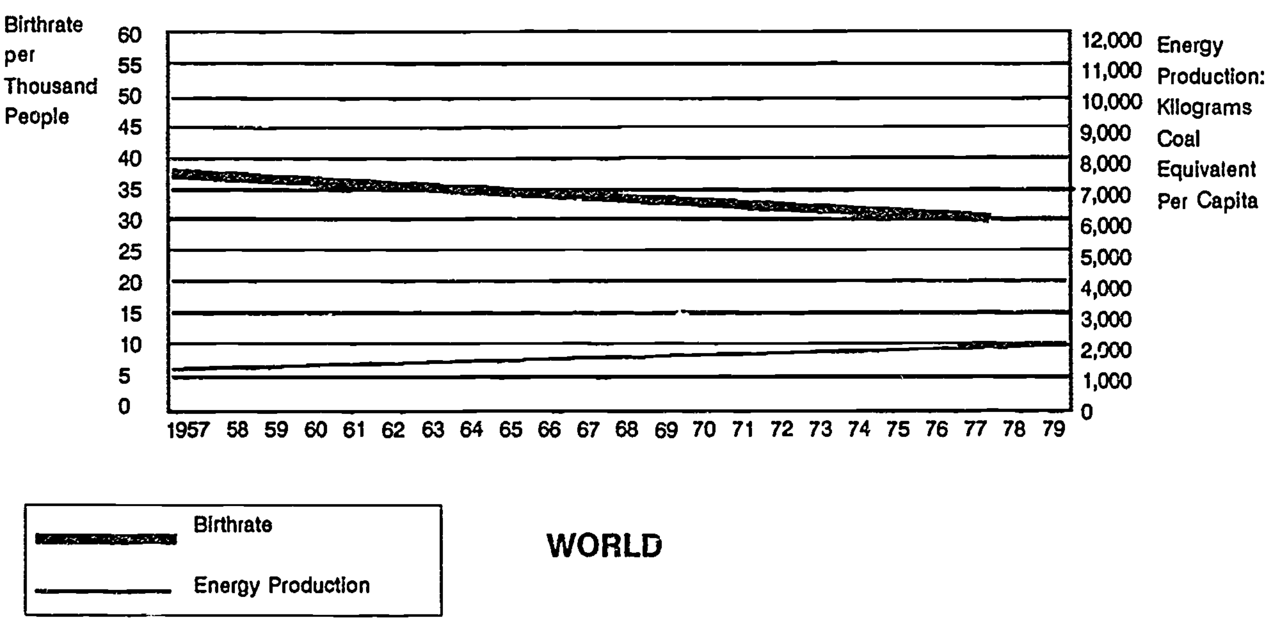
6. See graphs below.

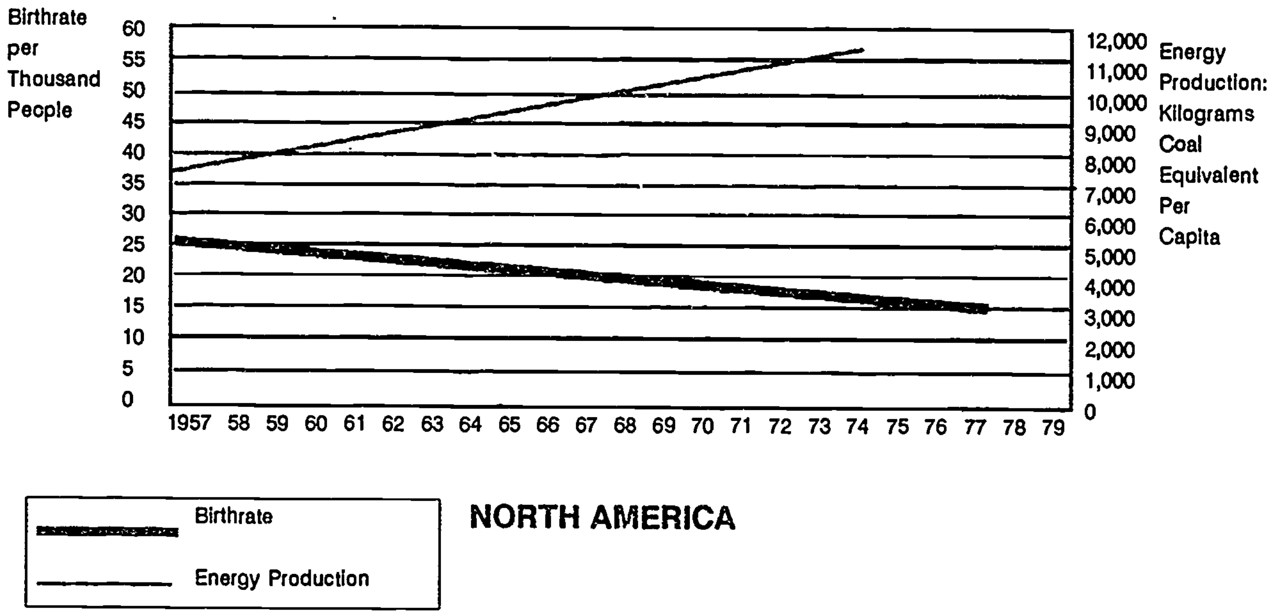
7. Generally the effect is less dramatic.

8. Answers will vary. It is hoped that students can get a little worked up and outraged at the manipulation of data.

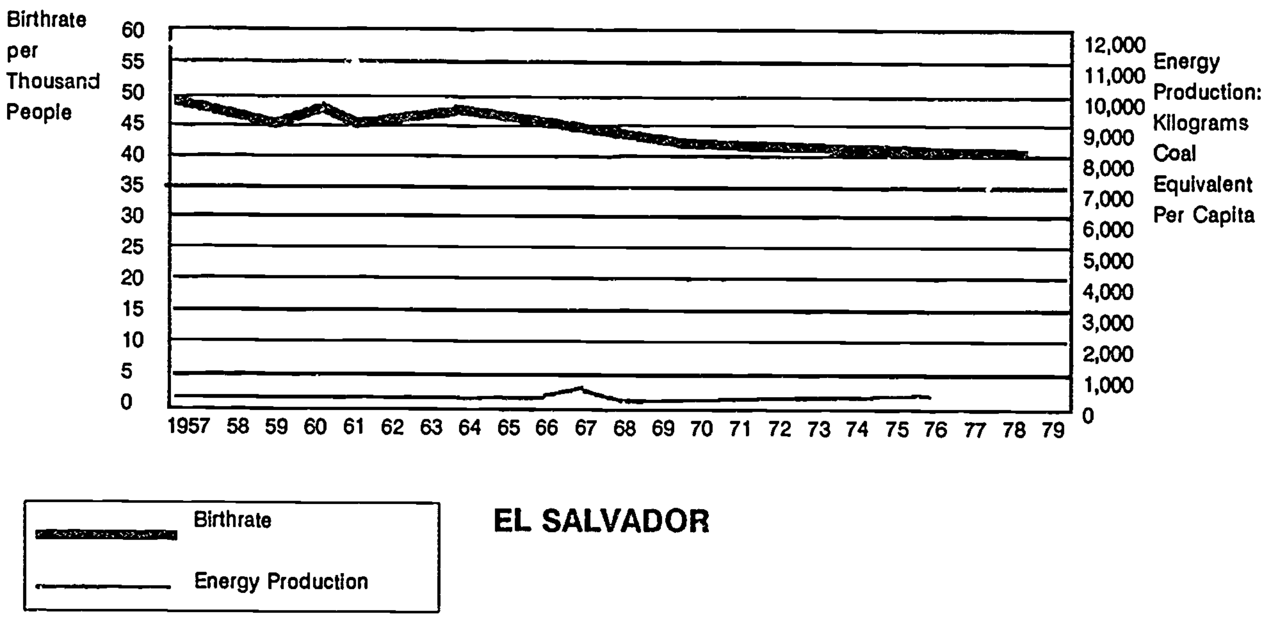
9. Graph 4 (North America) seems to best show the relationship.

10. Answers will vary.





NORTH AMERICA



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Teacher Background Notes

Deciphering statistics can be very difficult. Numbers seem to carry a lot of weight in an argument because they appear to be so precise. Getting beyond the numbers to full understanding is a challenging task.

Five Questions to Ask About Statistics and Graphs

A. Who Says So?

Does the person or organization reporting the information have something to gain by presenting the facts in a particular way? Example: Assume that a particular item sells at retail for $1.00. Assume that the wholesale cost is $.50. That information can be presented in at least two ways: The merchant might think to himself or herself, "I can mark this item up 100 percent ($.50 original cost multiplied times 2 equals a 100 percent markup) and sell it for $1.00." If a customer asked the store manager to comment on average markups, the manager might reply that the markup was only 50 percent (since 50 percent of the selling price represents markup).

Be aware of who is reporting and why it might be of some advantage for them to report data in a particular manner.

B. How Do They Know?

The way the information was collected can be very important. How many people were questioned? Where were the population, production, or other numbers obtained? Evaluating the sources of information is an important step in understanding the quality of the data. Example: "Three out of four people say that they are very happy carpooling to work each day." The quotation does not indicate how the information was collected. A poll would seem to be a reasonable method for collecting that type of information. Another method of finding the data would be to invent it. Another method might be to ask someone to estimate the number of people. The method of data collection is important. Graphs in particular often neglect to report the data collection method.

C. What's Missing?

Graphs in particular seldom include information about sources or how averages were developed. That can be very important. Example: "Three out of four people say that they are very happy carpooling to work each day." The missing information, as suggested above, is crucial. For this imagined poll, the unreported data are: only four people were polled; they work in the same office; one of the happy people, a woman, is married to one of the happy men; the third happy person supplies the car for the carpool but just broke his leg and couldn't get to work without the help of his friends; the single unhappy person is unhappy because he can't find anyone to carpool with.

The example illustrates many of the problems with polls. The number of people polled is crucial. How were those people selected for questioning? What were the exact questions asked? Were they asked in person or by written questionnaire?

Many graphs use only percentages. As seen in the example, if the percentage is reported without the absolute number of respondents, the results can be very misleading.

D. Did Someone Change the Subject?

Does the conclusion directly follow from the reported information? In the energy production and birthrate graphs, we are led to draw a conclusion that these two aspects of nations are absolutely connected, even that changes in one cause predictable changes in the other. Is that cause-effect relationship so clear?

There is a difference between cause-effect connections and correlational effects. Cause-effect relations must make it very clear that a change in item A absolutely results in a change in item B. Example: I drop item A—a hammer—on my toe. Immediately afterward my toe hurts—item B. There is a strong causal relationship between dropping the hammer and the pain in my toe. Unfortunately, most relationships in this complex world are not nearly so clear. Most relationships are merely correlational.

Correlations appear when a change in one item, a change in another item, and probable changes in many other items seem to occur in sequence or together. It is tempting to say that a change in one factor *causes* the changes in the other items. Example: Most people have two eyes. Most people have two legs. Therefore, being born with two eyes causes people to have two legs.

We can draw an example from our graphs: Increasing the production of energy takes lots of money. Rich people have lots of money. Therefore, if we create more rich people, the birthrate will fall. That is exactly what the graphs could imply, but clearly, piles of money, in themselves, do not affect birthrate. There are many spinoffs from the possession of money that appear to be related to choices in procreation. Most of them probably do not cause drops in the birthrate.

E. Does It Make Sense?

Not all statistics and graphs report findings that coincide with our intuitions. If an element of absurdity—or at least questionability—exists, then the report must be examined more carefully.

Resources:

Fuller, R. Buckminster, *Critical Path* (New York: St. Martins, 1981).

Gabel, Medard, *Ho-Ping: Food for Everyone* (Garden City, NY: Anchor Books, 1979).

Jacobson, Willard J., *Population Education: A Knowledge Base* (New York: Teachers College Press, 1979).

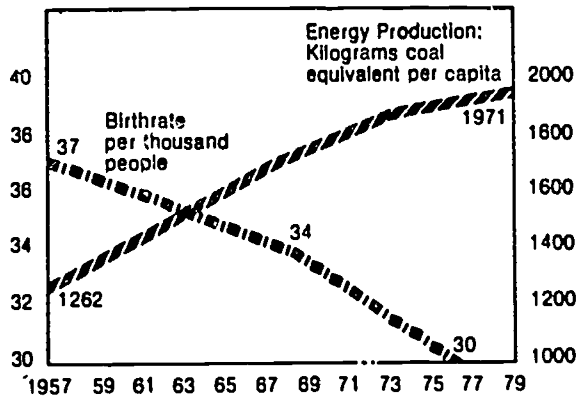
Population Information Program, Johns Hopkins University, Hampton House, 624 North Broadway, Baltimore, MD 21205.

Population Reference Bureau, 2213 M Street, NW, Washington, DC 20037.

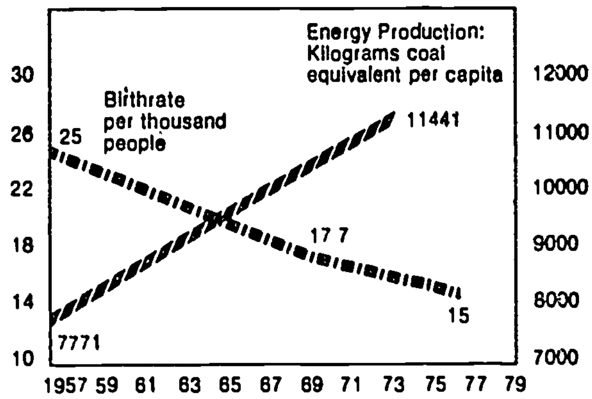
United Nations Fund for Population Activities, 1120 19th Street, NW, Washington, DC 20036.

POPULATION AND ENERGY PRODUCTION GRAPHS

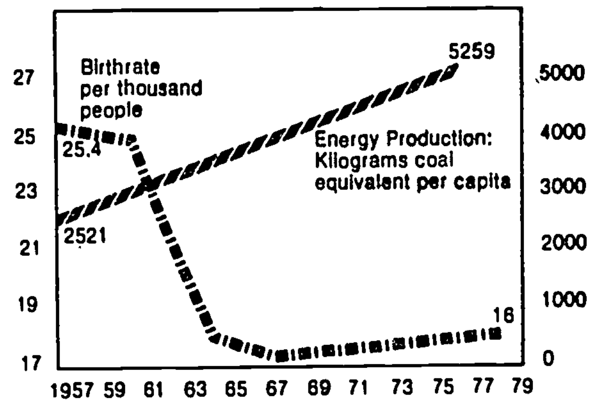
A. World



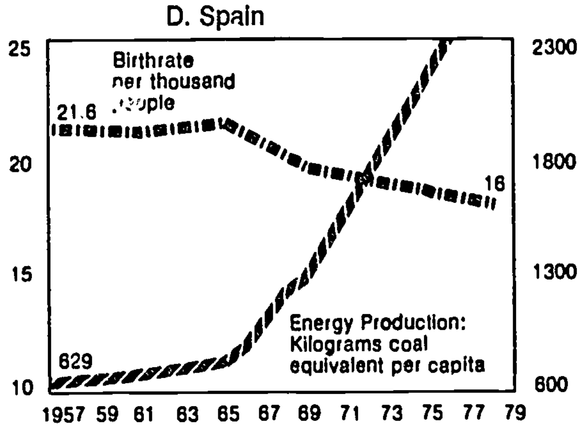
B. North America



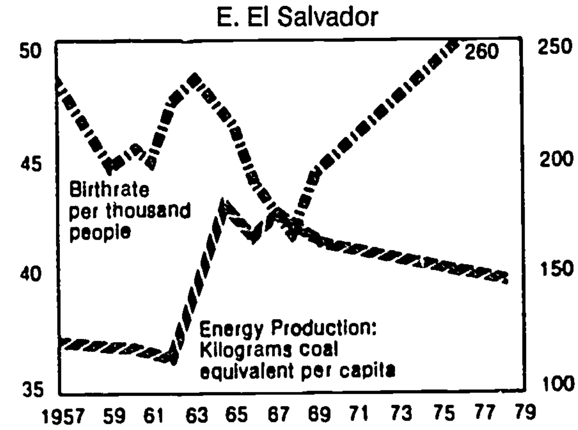
C. U.S.S.R.



D. Spain



E. El Salvador



Source: *Ho-Ping: Food For Everyone*, by Medard Gabel (Garden City, NY. Anchor Books, 1979).

READING POPULATION AND ENERGY PRODUCTION GRAPHS

Examine the graphs carefully. Two different factors are combined on the graphs, so read them carefully for full understanding. Then answer the questions that follow. Some of the questions are about how to read the graphs. Some ask what each graph says. Some questions will ask you to go beyond the information on the graphs.

1. What do the numbers on the left side of each graph measure?

____

2. What do the numbers on the right side of each graph measure?

____

3. What do the numbers on the bottom of each graph measure?

____

4. What does "Birthrate per thousand people" mean?

____

5. What is the meaning of "Kilograms coal equivalent per capita"?

____

6. According to Graph A, what was the world birthrate per thousand people in 1957?_____ In 1969?_____ In 1977?_____

7. According to Graph A, what was the total energy production, in kilograms coal equivalent per capita, in 1957?_____ In 1969?_____ In 1979?_____

8. Describe the trend in world energy production per capita shown in Graph A.

____

9. Describe the trend in world birthrate per thousand people shown in Graph A.

____

10. What nation does Graph D depict?

____

11. Describe the trend in birthrate shown in Graph D.

____

12. Describe the trend in energy production in Graph D.

____

13. How do the birthrate and energy production trends in Graph A compare to the trends in Graph D?

14. Are these trends the same in all of the graphs?

15. What do the graphs imply about the relationship between energy production and birthrate?

16. In terms of world political power, it seems obvious why North America and the Soviet Union were included among these nations. Why were Spain and El Salvador included?

17. Do energy production and birthrate reflect or demonstrate political power? If so, how?

18. How has energy production increased over the years 1959-1977?

19 List three ways that an increase in the availability of energy might lead to a decrease in the birthrate.

20. If the suggested relatic ship between energy production and birthrate is correct, what is being suggested as a means of world population control?

21. If the trend shown in the graphs is extended into the future, how effective should that method of population control be?

22. Explain in a five-sentence paragraph why you agree or disagree with the idea that increasing the availability of energy will continue to result in a decline in the world birthrate. Include examples that support your position. Write your paragraph on the back of this sheet.

REEXAMINING POPULATION AND ENERGY PRODUCTION GRAPHS

Look at the graphs on Handout 13-1 again and answer these questions. You will need to check the labels on each graph carefully and compare them to each other.

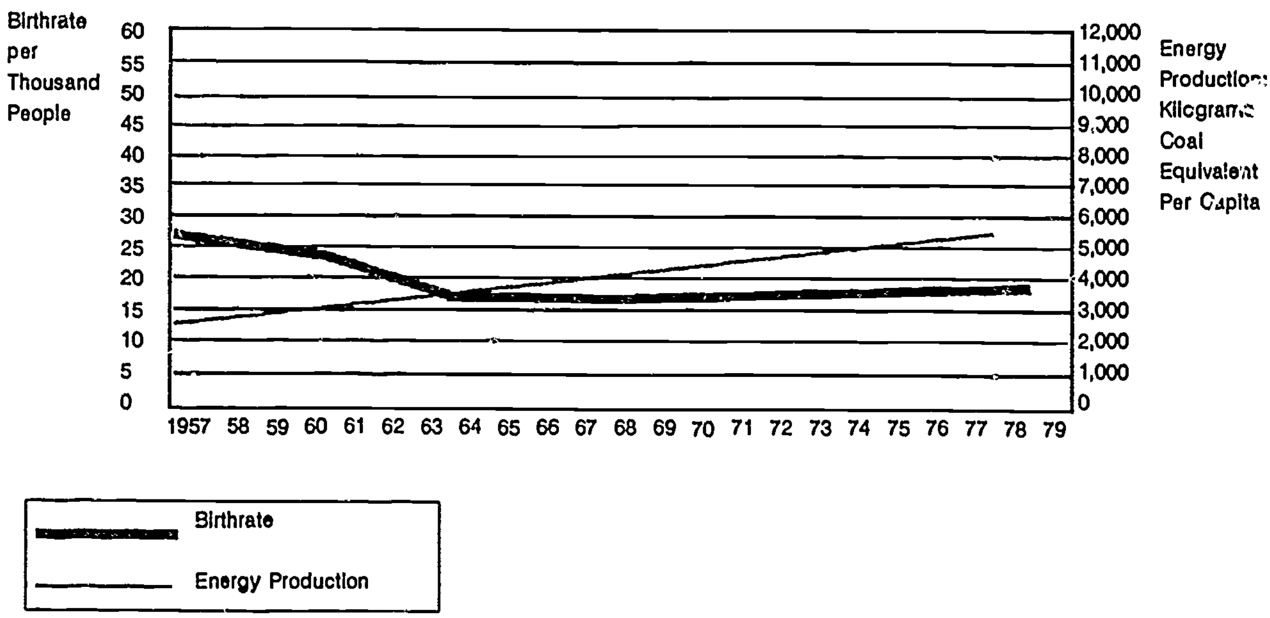
1. On Graph A, what is being measured by the numbers on the right side of the graph?

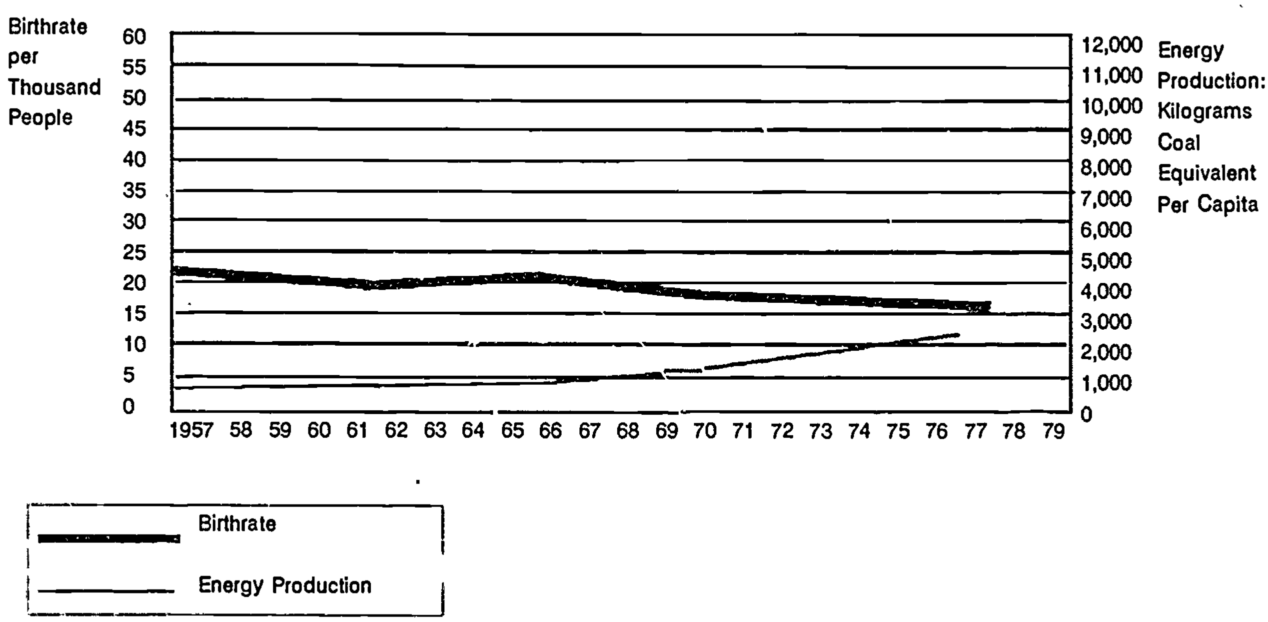
____

2. What is the least number of kilograms coal equivalent per capita that can be shown on this graph?_____ The highest?_____

3. Compare the Energy Production scale on Graphs B and E. What is the lowest measure on B?_____ On E?_____ The highest on B?_____ On E?_____

4. While the overall trends of Graphs B and E are similar and the graphs appear very much the same, the numbers are quite different. Examine the two graphs below. These two graphs use the same data as two graphs on Handout 13-1, but the scales have been redrawn so they are the same. Examine them carefully. Write the country or region shown in each graph on the line above it.





Note the different effect achieved by redrawing the graphs. How do you think these visual differences might change the way the data could be interpreted? (For example, which presentation of the energy/birthrate relationship is more dramatic—and why?)

____

____

____

5. Who (what groups) might be interested in presenting the graphs as shown on Handout KK-1? The ones on this page?

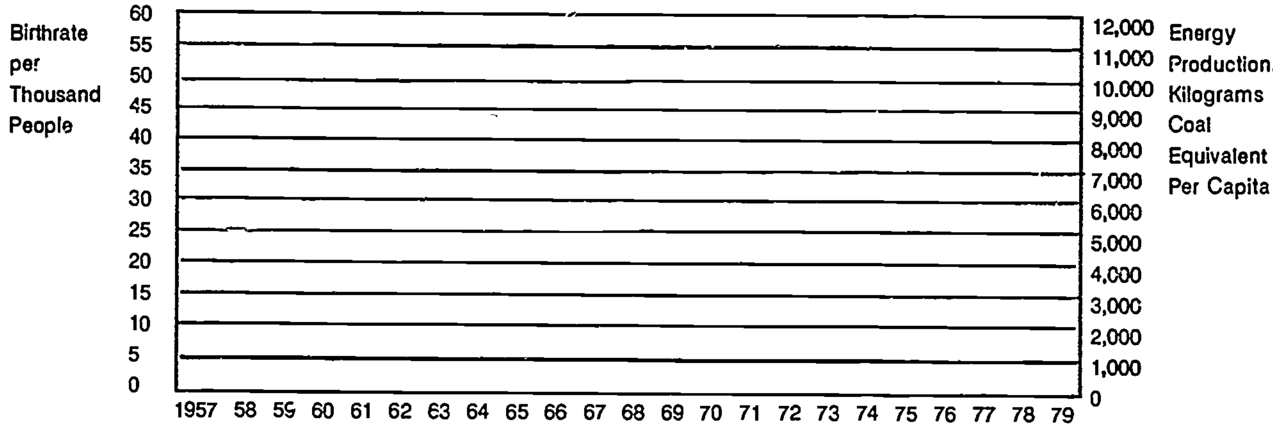
____

____

____

6. Redraw Graphs A, B, and E on the following page.

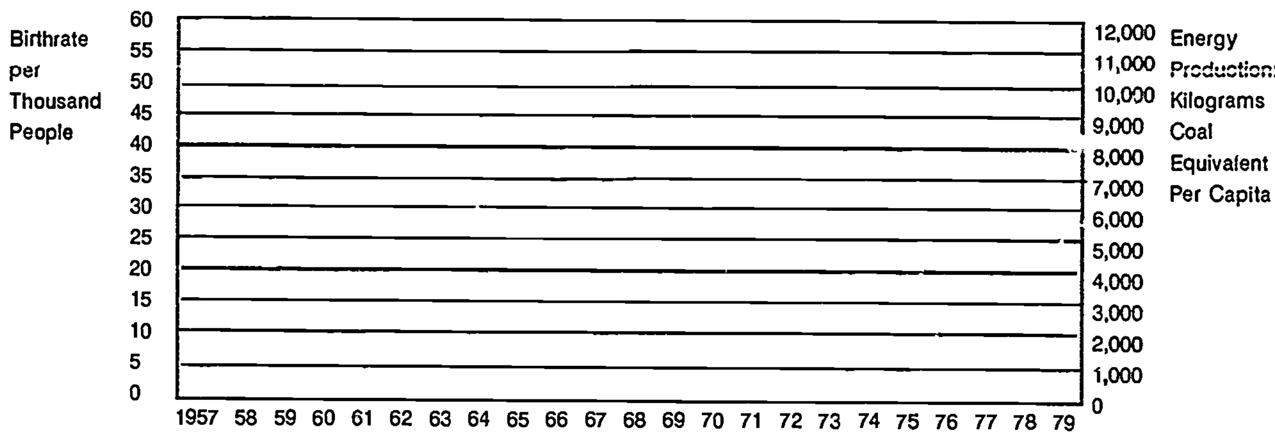
69



Birthrate

Energy Production

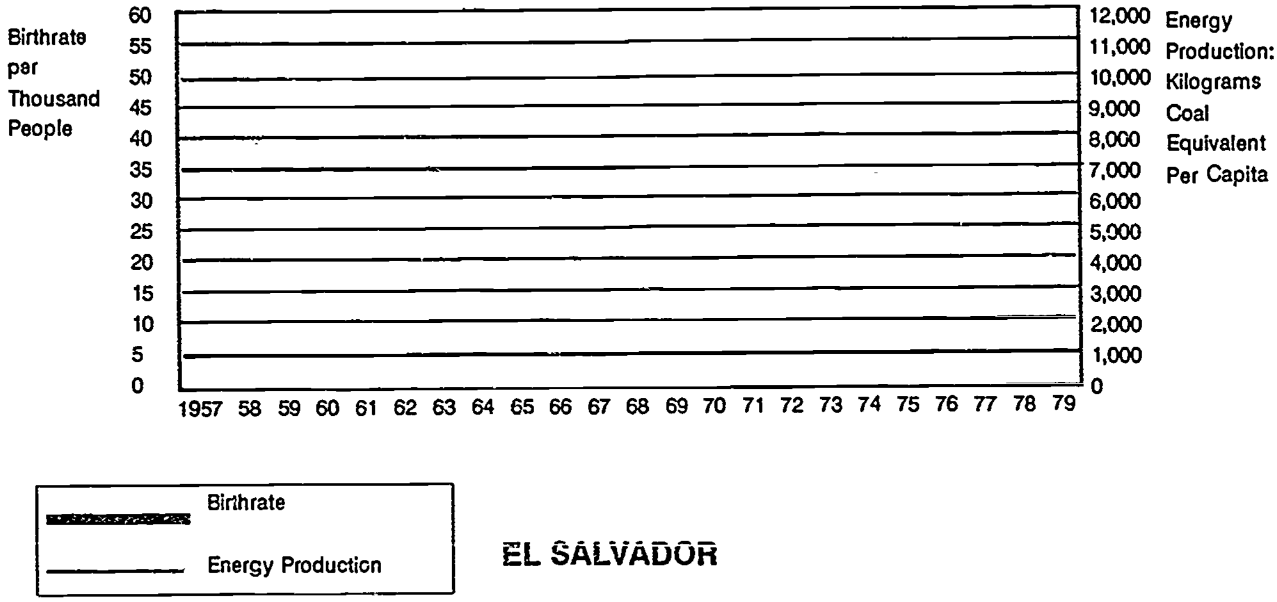
WORLD



Birthrate

Energy Production

NORTH AMERICA



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7. Compare Graph E to the new El Salvador graph. Graph E shows a dramatic relationship between birthrate and energy production. How does the perception of that relationship change when viewed in the new graph?

____

____

8. How significant is the difference in the presentations to your perception of the relationship? Is the relationship less convincing to you now?

____

____

9. Compare the five new graphs. Which graph best shows that when energy production increased, the birth rate per thousand decreased? Which graph is the least convincing in showing this relationship?

____

____

10. These graphs *still* seem to say that increasing the availability of energy (usually as electric power) causes a drop in the birth rate. This is often described in terms of raising the standard of living as a means of reducing the birthrate. We have discussed some factors that might be involved in making this relationship true. Turn that around now. Brainstorm a list of FIVE ways that "prove" that *falling birthrates* cause energy production to increase.

14. FISH KILL IN RIVERWOOD

Introduction:

While the city and citizens of Riverwood exist only on these pages, their problem could be real. The chemical facts, principles, and procedures explored here, as well as the government decision-making processes, directly apply to a wide range of experiences in our homes and communities.

The lesson involves students in role playing a town council meeting. As part of the debriefing of the role playing, students write letters to the editor advocating actions based on the hearings.

Objectives: Students will be able to:

1. Explain the causes and effects of an ecological accident.

2. Describe several expert views on the problem.

3. Identify the steps in civic decision making.

4. Recognize the value of expert testimony in reaching decisions on science-related social issues.

Subject/Grade Level: Civics/grade 9; economics/grade 12; government/grade 12; current events/grades 9-12; chemistry/grade 11; ecology/grade 10, environmental studies/grades 9-10

Time Required: 3-4 class periods

Materials and Preparation: Make copies of Handouts 14-1 and 14-2 for all students, make two sets of Role Cards. You may wish to make a transparency of the proposed spillway deflector system.

Procedures:

1. Distribute Handout 14-1 to students and allow time for reading. Check for understanding by asking factual questions about the two news articles.

2. Select three students as the Town Council members. Then divide the rest of the students into six groups. Distribute Handout 14-2 to each student. Distribute a Role Card to each group, giving the Town Council a complete set of cards to aid in their planning. Allow the balance of the period for planning.

3. Allow 10 minutes for final planning while you review procedures with the Town Council group.

4. Bring the groups to attention, introduce the council members, and seat them at the front of the room. Review the assignments and have the council begin the meeting.

5. After the presentations, have students begin their letters to the editor. Letters are to be completed as homework.

6. Collect the homework. Debrief the presentations. Poll students for their positions on each of the eight questions. Have individual students explain their reasoning. Which groups had the most effective presentations? Why? Based on the consensus of the class, what do they think Riverwood did? Of what use was the selenium information?

Source. Adapted from *ChemCom. Chemistry in the Community* (Dubuque, IA. Kendall/Hunt, 1988).

7. The **Teacher Background Notes** may be helpful in the final debriefing of the lesson. A crucial point is that scientific facts do not exist in isolation. Even when the facts are clear, people must make choices based on their evaluation of those facts.

Evaluation:

The letters to the editor can be used to evaluate content learning. You may also want to have students write a brief rationale for taking expert testimony to evaluate their achievement of the process and attitude objectives.

Extension/Enrichment:

1. As an alternative to preparing a letter to the editor, groups may prepare videotaped interviews. A spokesperson from each group should be questioned by a television interview team.

2. Students can explore local environmental issues by contacting the chamber of commerce, the local newspaper, or state and local environmental groups. Students may want to make recommendations to the city council, or other planning board, based on their research.

Teacher Background Notes:

The Riverwood water mystery has finally been solved, even though the issue of what to do about it remains. It is ironic that the water "contaminants" responsible for the fish kill and for the town's understandable concern are just excessive amounts of oxygen gas and nitrogen gas dissolved in the water. Neither substance qualifies as toxic or dangerous—after all, we live immersed in an atmosphere of these gases.

However, deep sea divers have long feared and respected the hazard known as the "bends"—the formation of nitrogen gas bubbles in a diver's blood if bodily pressure is lowered too rapidly in moving back to the water surface. Thus, even for humans, a substance as seemingly harmless as nitrogen gas can pose life-threatening risks under certain conditions.

Although the analogy is not perfect, the gas bubble disease that caused the fish kill can be considered a form of the bends. In fact, the same scientific principle that explains the fizzing of a carbonated beverage accounts for both of these hazardous situations.

Did all of the earlier water analyses in the Snake River represent a waste of time and money? Of course not. Even though the tests failed to locate a probable cause for the fish kill, they eliminated several major possibilities and thus narrowed the field of investigation. In scientific research, negative results may be as important and useful as positive ones.

In the case of the Riverwood investigation, an unexpected finding has given chemists an "early warning" of a possible future water-quality problem. The selenium concentration in the Snake River, although not responsible for the fish kill, has increased enough over the past few months to merit serious attention and action by the authorities. If the fish kill had not happened, would this potential problem have been identified this soon? Possibly. But it's not unusual for a systematic search for a solution to one scientific or technological problem to uncover one or more new problems. In fact, this is partly why scientific work is considered so challenging and interesting by those who work as scientists and technicians.

WHO PAYS THE CONSEQUENCES?

Fish Kill Cause Found; Meeting Tonight

A little-known condition called "gas bubble disease" caused the massive fish kill in the Snake River, announced Mayor Edward Cisko at a news conference early today. The water condition that prompted onset of the disease is not harmful to humans, however.

With Mayor Cisko at the conference was Dr. Harold Schmidt of the Environmental Protection Agency laboratory.

Dr. Schmidt explained that the disease is caused by an excess of air dissolved in the river water. "The excess dissolved air, mostly nitrogen," he continued, "then passes through the fish's gills, where it forms gas bubbles. Consequently, less oxygen circulates though the fish's bloodstream. The fish usually die within a few days if the situation is not corrected."

Dr. Schmidt described dissecting sample fish within a short time after death and finding evidence of the gas bubbles, the only positive identification of the disease.

Dr. Schmidt gave assurances that river water with supersaturated air dissolved in it is not harmful to human health, and that the town's water supply is "fully safe to drink."

Mayor Cisko refused comment on reasons for the super-aerated water, saying, "The cause is still under investigation." But an informed source close to the mayor's office stated that "The most likely source of the super-aerated water was the power company's release of water from the dam upstream of Riverwood." The mayor's secretary confirmed that power company officials will meet with the mayor and his staff later today.

Mayor Cisko also announced that there would be a special Town Council meeting at 8 p.m. tonight in the Town Hall. The council will address two questions: Who is responsible for the fish kill, and who should pay for water trucked to Riverwood during the three-day water shutoff? Several area groups plan to make presentations at tonight's meeting, which is open to the public.

Editorial: Special Council Meeting

Tonight's special Town Council meeting could result in important decisions affecting all Riverwood citizens. The council meeting will address two primary questions. Who is responsible for the fish kill and who should pay for the water that was trucked into Riverwood during the three-day water shutoff? These questions have financial consequences for all town taxpayers.

Those intending to request speaking time at tonight's public meeting include power company officials, scientists involved in the river water analyses, engineers from an independent consulting firm familiar with power plant design, Chamber of Commerce members representing Riverwood store owners, representatives from the County Sanitation Commission, and the Riverwood Taxpayers Association.

We urge you to attend the meeting. Many unanswered questions remain regarding the fish kill.

1. Was the fish kill an "act of nature" or was some human error involved?

2. Was there negligence?

3 Should the town's business community be compensated, at least in part, for financial losses experienced due to the fish kill?

4. If so, how should they be compensated, and by whom?

5. Who should pay for the special drinking water brought into Riverwood?

6. Can this situation be prevented in the future?

7. If so, at what expense?

8. Who will pay for it?

This newspaper will devote a large portion of its Letters to the Editor column in the coming days to your comments on these and other issues related to the community's recent water crisis.

DIRECTIONS FOR TOWN COUNCIL MEETING

Your group will be making a presentation at the emergency meeting of the Riverwood Town Council. You will receive some suggestions on information to include in your group's presentation. Consider these suggestions only as a starting point. Identify other points to stress in your presentation.

Use your group's planning time to select a spokesperson and to organize the information to be presented. You may wish to prepare written notes to use during your group's presentation. Each group will have two minutes to present its position and one minute for rebuttal time. Failure to stay within the presentation time limits will result in loss of rebuttal time. Students assigned to the town council group will act as official timekeepers. Listen carefully to the presentations, taking notes on each group's position.

Following the meeting, each student will write a letter to the editor of the Riverwood newspaper. Your letter must take a position on each of the eight questions posed in the editorial reprinted in Handout 14-1.

Meeting rules and penalties for rule violations

1. The order of presentation is decided by council members and announced at the start of the meeting.

2. Each group will have two minutes for its presentation. Time cards will notify the speaker of time remaining.

3. If a member of another group interrupts a presentation, the offending group will be penalized one-half minute for each interruption, to a maximum of one minute. If the group has already made its presentation, it will forfeit its rebuttal time.

ROLE CARDS

Town Council members

Your group has responsibility for conducting the council meeting in an orderly manner. Be prepared to do the following:

1. Decide and announce the order of presentations at the meeting. Groups presenting factual information should be heard before groups voicing opinions.

2. Explain the meeting rules and the penalties for violating those rules (see Handout 14-2).

3. Recognize each special interest group at its assigned presentation time.

4. Enforce the two minute time limit on presentations. One suggestion for maintaining the time limit is to prepare time cards with one minute, one-half minute, and zero minutes written on them. These cards, placed in the speakers' line of sight, will notify them of the time left for their presentations.

Power company officials

In preparing your presentation, keep the following information in mind:

The release of water from the dam is a standard procedure to prevent flooding. The potential for flooding was increased due to the unusually heavy rains experienced in the area this past summer. The last time it was necessary to release such a large volume of water from the dam was 30 years ago. A fish kill was reported then, but the cause remained unknown. On that occasion, Riverwood and the surrounding area also had experienced an unusually wet summer. Normally only small volumes of water are released from the dam at any particular time.

The dam was constructed in the 1930s using the most current design of the time. Its basic design has not been altered since it was constructed.

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Scientists

In preparing your presentation, keep the following information in mind:

Gas bubble disease is a noninfectious disease that has only recently been identified. It is caused by excessive gas dissolved in the water. When the total amount of dissolved gases, primarily oxygen and nitrogen, reaches a combined total of 110-124 percent of saturation, symptoms of gas bubble disease can occur in fish. There are no known harmful effects of such water to humans.

The most dangerous component is the excess nitrogen dissolved in the water. Fish metabolism can partially reduce the effect of excess oxygen through hemoglobin-oxygen transport, but there is no such mechanism for transport of nitrogen in blood.

Fish die because the supersaturated gases in the water produce gas bubbles in their blood and tissues. These bubbles often form in blood vessels of the gills and heart. Death results, since blood is unable to circulate throughout the fish's bodies. Some fish varieties also develop distended (bloated) air bladders. Fish death can occur from a few hours to several days after the formation of the gas bubbles.

A definitive indicator of gas bubble disease is the presence of gas bubbles in the gills of dead fish. However, some gas bubbles disappear rapidly after fish die, so prompt dissection and analysis are required.

Supersaturation of the water with oxygen and nitrogen gas often occurs near dams and hydroelectric projects whenever water is released and forms "froth," trapping large amounts of air. Water at the base of the dam may have oxygen and nitrogen dissolved at 139 percent of saturation, while 90 km (about 56 miles) downstream, the supersaturation may still be as high at 111 percent of saturation. The Environmental Protection Agency limit for combined oxygen and nitrogen supersaturation in rivers is 110 percent. Specially designed spillways providing more gradual release of water from dams may substantially lessen or even prevent supersaturation of the released water.

Engineers

In preparing your presentation, keep the following information in mind:

Engineers can predict whether large amounts of air will be trapped in water released from a dam spillway. This can be done with knowledge of the physical structure of the spillway and the volume of water that will be released.

The U.S. Corps of Engineers has conducted research on whether operational or structural changes in dams might reduce the chance of gas supersaturation in released water. Their main goal has been to find ways of reducing the volume of water released from spillways and preventing the released water from plunging to great depths beneath the river surface. When water plunges to great depths, the increased pressure can force greater amounts of air to dissolve in the water.

Three specific suggestions could be helpful in Riverwood's situation. The first is to enlarge the reservoir upstream from the dam. This would provide greater water storage capacity during times of heavy rain and runoff. Water could thus be released from the spillway in smaller quantities, decreasing the chance of high gas supersaturation.

The second suggestion is to launch a major fish-collecting operation upstream from the dam. The fish could then be trucked around the dam and released at a downstream location where the supersaturation level was low enough to ensure fish survival.

The third suggestion is to install deflectors on the downstream side of the spillway. Spillway deflectors avoid creating high levels of dissolved air by preventing released water from plunging to great depths. Instead, they release the water along the river surface where the chance of large quantities of air dissolving is reduced.

Chamber of Commerce

In preparing your presentation, keep the following information in mind:

Canceling the annual fish tournament will cost Riverwood merchants a substantial sum. Nearly 1000 out-of-town participants were expected to take part in the tournament. Many participants were expected to rent rooms for at least two nights and to eat in local restaurants and diners. In anticipation of this business, extra help and food supplies had been arranged. Fishing and sporting goods stores had stockpiled extra fishing supplies. Some businesses have applied for short-term loans to help pay for their extra, unsold inventories.

Local churches and the high school had planned family social activities as revenue-makers during the tournament. The school band, for instance, planned a benefit concert for the tournament weekend. The concert would have raised money to send band members to the spring state band competition.

The public will likely remember the fish kill in future years. Tournament organizers predict that revenues from future fishing competitions in Riverwood will be substantially reduced due to the adverse publicity generated this year. Thus, the total financial losses due to the water emergency may be much higher than those currently projected.

County Sanitation Commission

In preparing your presentation, keep the following information in mind:

The Snake River water analysis following the fish kill verified that Riverwood drinking water is safe according to Environmental Protection Agency guidelines. One water contaminant that has significantly increased since earlier river tests is selenium. Despite its increase in concentration, selenium's 0.008-ppm level is still below the EPA's 0.01-ppm limit.

The main source of selenium in water is soil runoff. The concentration of selenium in soil varies by region, depending on the source of the soil. Selenium-containing soil near Riverwood came from the debris of prehistoric volcanic eruptions which carried selenium from within the earth's crust to its surface.

Selenium is essential to human and animal health in trace amounts. However, if ingested in too great amounts, its toxic effects are similar to those of arsenic poisoning.

The recommended human dose of selenium is 0.05 mg to 0.20 mg per day. It is contained in foods such as wheat, asparagus, and seafood. The body needs selenium to assist enzymes in protecting and repairing cell membranes. Due to this action, it is thought by some authorities—at least in trace amounts—to help prevent cancer.

Riverwood Taxpayer Association

In preparing your presentation, keep the following information in mind:

Who will pay for the water that was brought into the town during the water shutoff?

Will taxes be increased to compensate local business people for the financial losses they have experienced? (Keep in mind that the local merchants are most likely Riverwood taxpayers themselves!)

If the power company redesigns the dam's spillway, will the cost of construction be passed on to the taxpayers? If so, how?

How much (if at all) should the information presented by the other groups influence your position concerning who pays? If possible, you may wish to obtain written briefs from the other groups before the town meeting. What other sources of information might be useful?

15. SOLVING THE PROBLEMS OF THE WORLD

Introduction:

Many of the problems facing the world today are the consequences of geographic realities. The tilt and rotation of the earth create inexorable forces that dictate many of the tectonic and weather patterns we experience. In this lesson, students examine some global physical conditions and propose solutions to problems generated by those realities.

Objectives: Students will be able to:

1. Explain how physical geography affects people's lives.

2. List several problems caused by global geography.

3. Analyze maps to identify world problems.

Subject/Grade Level: World geography/grades 7, 10; current events/grades 7-12, earth science/grade 8

Time Required: 2-3 class periods

Materials and Preparation: Make a copy of Handout 15-1 for each group of four or five students and copies of Handout 15-2 for all students. Each group will also need poster paper, markers, and a supply of Presentation Evaluation Forms.

Procedures:

1 Ask the group to think of any problems caused by geography. With younger students, you may need to suggest a few examples to get students started. List students' suggestions on the chalkboard. Then tell students that this lesson is going to focus on problems that people face because of geography. They will be using one of the geographer's basic tools—maps—to identify the problems.

2 Divide the class into groups of four or five students. Give each group a set of the maps (Handout SS-1) Allow a few minutes for students to examine the maps. Ask a few basic questions to insure that students understand the purpose of each map and how it presents information.

3 Distribute Handout 15-2 and go over the assignment with students, answering any questions they may have. Allow the remainder of the class period for the groups to work on the assignment. Be sure groups have poster paper and markers.

4 During the second class period, allow at least half of the period to continue working on the assignment. If students need the time, you may wish to allow the entire class period.

5 Give each group a supply of Presentation Evaluation Forms. Explain that students are to listen to the presentations of the other groups and complete one evaluation form—as a group—for each presentation These forms will be used to evaluate the work of the group making the evaluation, as well as the group making the presentation. Be sure students understand the criteria on which they are to evaluate the presentations.

6 Allow five to seven minutes for each group's presentation, followed by three to five minutes for completion of the evaluation forms.

Source: Adapted from *Teaching About the Future: Tools, Topics, and Issues*, by John D. Haas and others (Boulder, CO: Social Science Education Consortium, 1987). Maps drawn by Randall LaRue.

7. Debrief the lesson by discussing how geography affects people's lives.

Evaluation:

Collect the Presentation Evaluation Form[illegible] [illegible]se them to evaluate not only the quality of the groups' presentations, but also how well [illegible] [illegible]e able to evaluate the thinking demonstrated in the other presentations.

Extension/Enrichment:

Point out that humans often do things that make the problems caused by nature worse. For example, the way land has been used in the Sahel (the area south of the Sahara) has combined with climate conditions to create periodic famines. In the United States, plowing of the Great Plains combined with climate conditions to create the Dust Bowl of the 1930s. Have students conduct research on one of these or another example of how humans have made geographic problems worse. How could these problems be avoided in the future?

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Figure 1
Climate

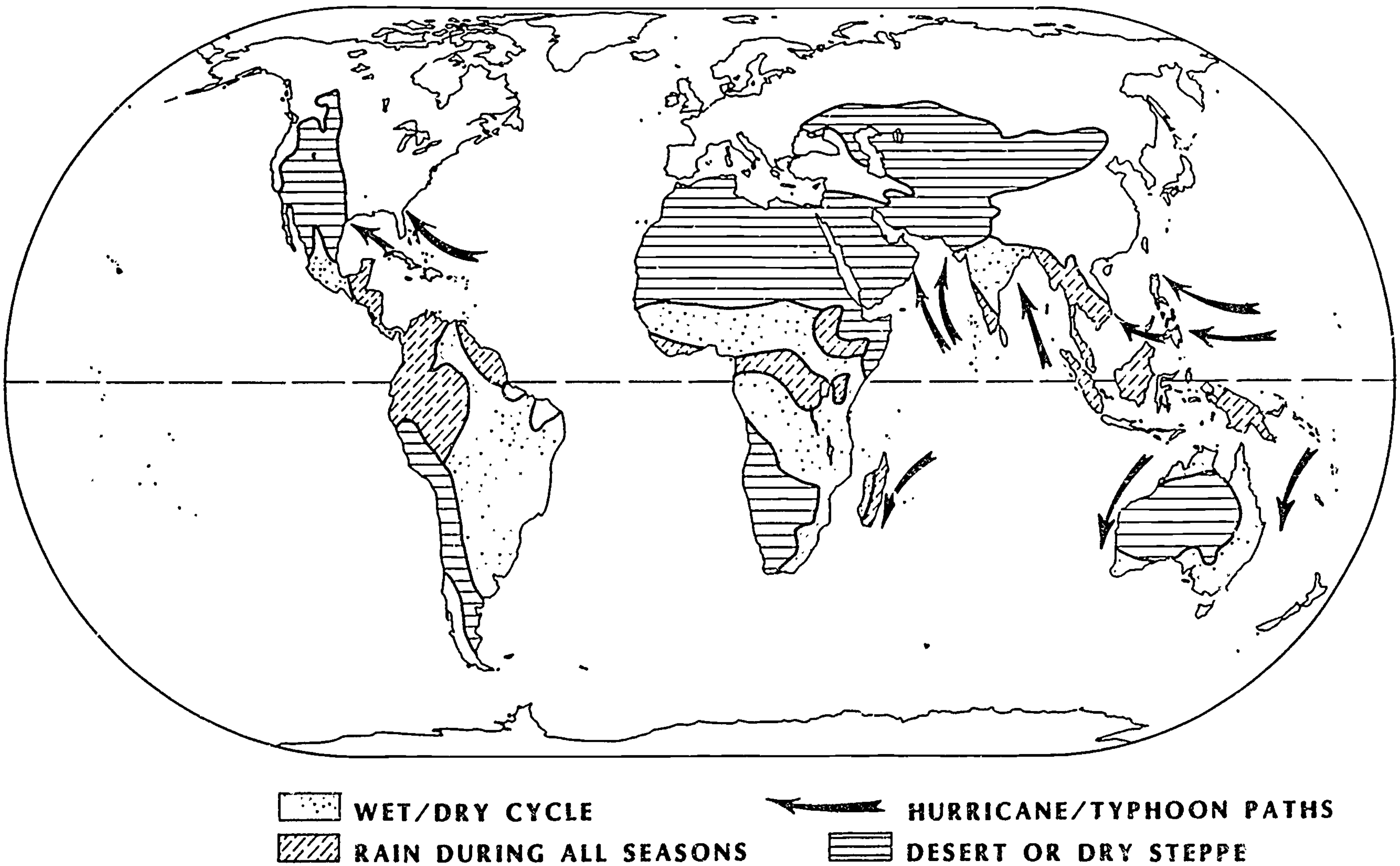
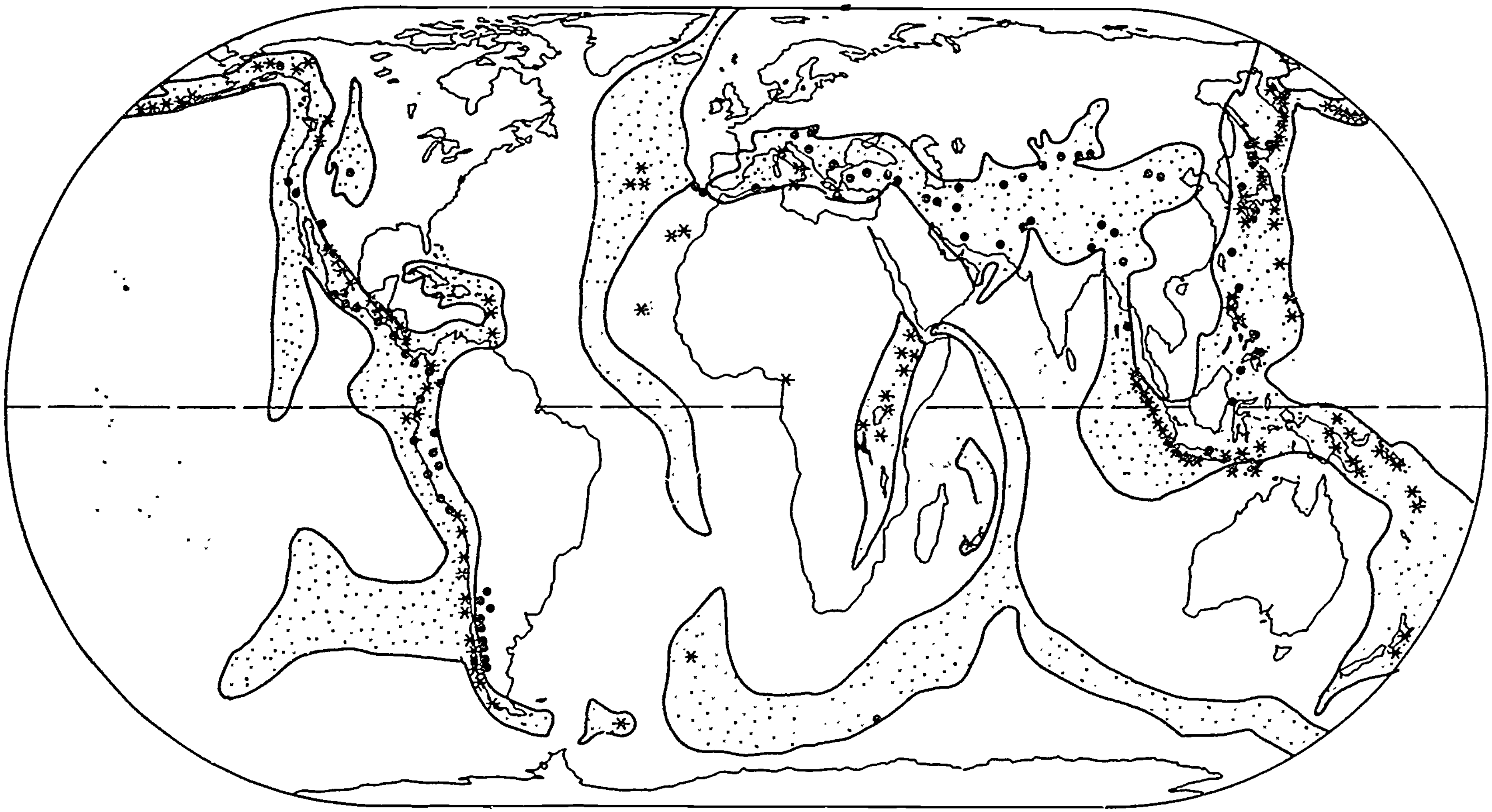


Figure 2
Earthquakes and Volcanoes



AREAS OF FREQUENT QUAKES

• MAJOR EARTHQUAKES

* ACTIVE VOLCANOES

Figure 3
Pests and Diseases

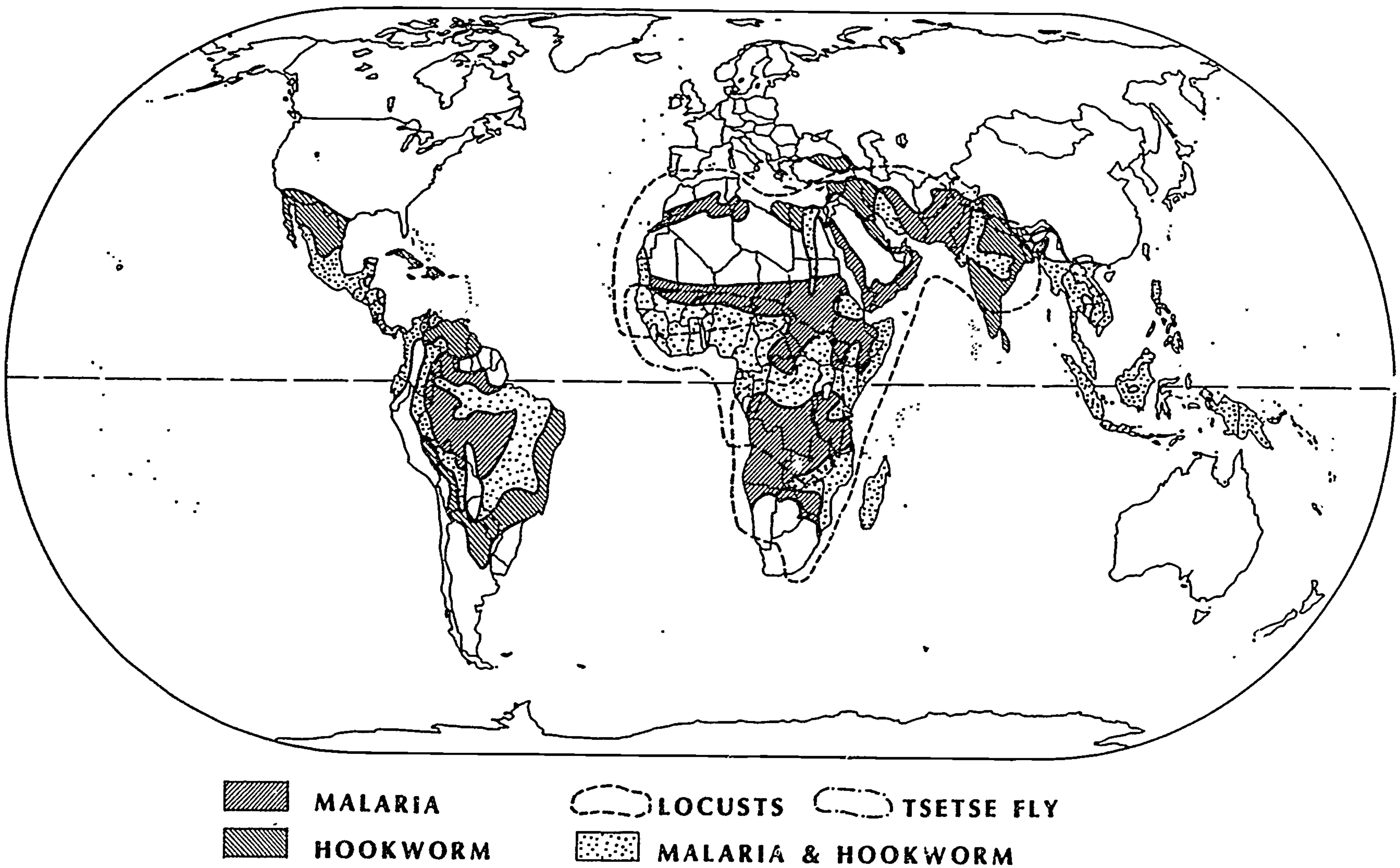
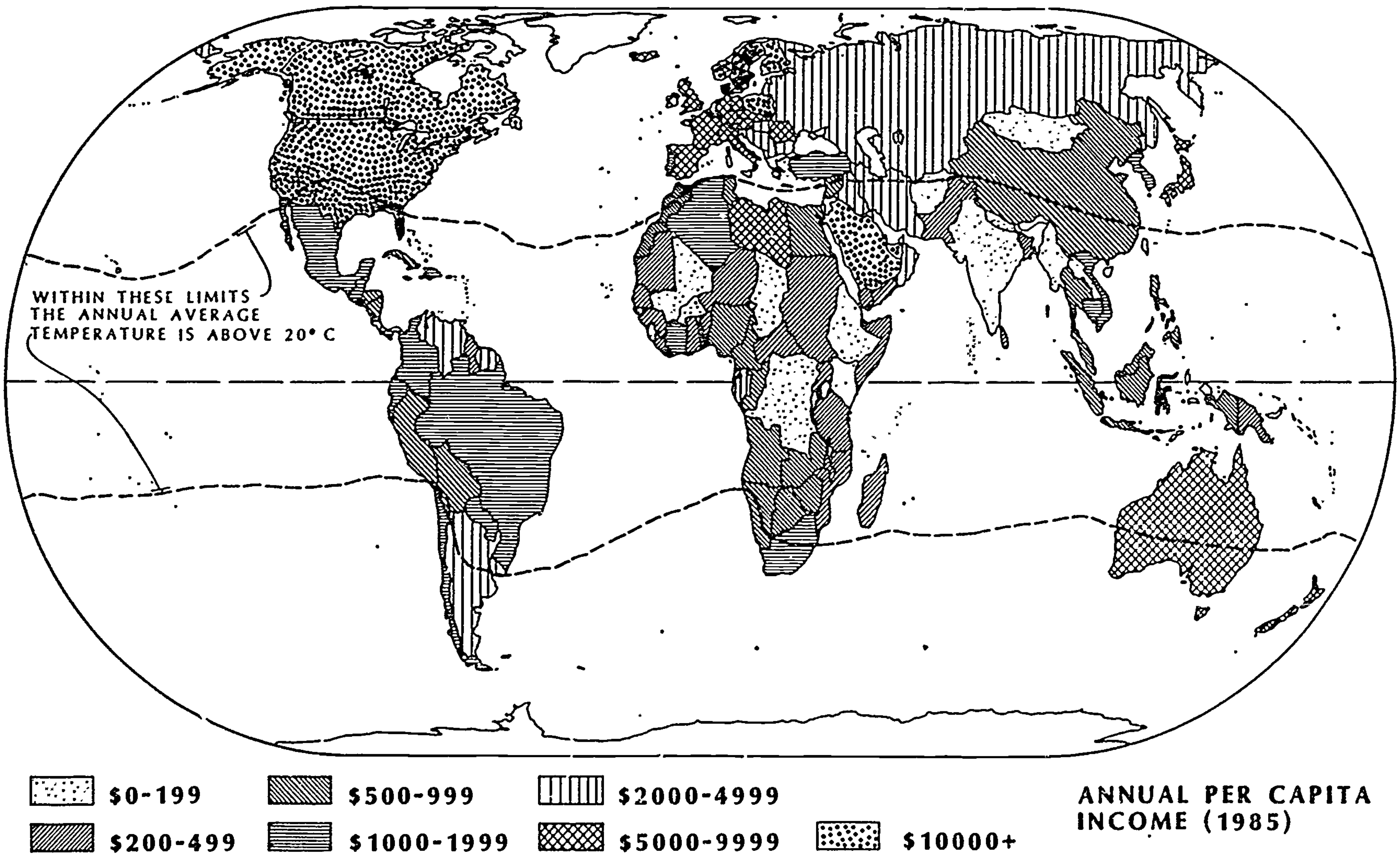


Figure 4
Temperature and Income



WORLD PROBLEMS AND GEOGRAPHY ASSIGNMENT SHEET

The Amalgamated Global Consortium, a public service organization of nations and multinational corporations, has hired your group to develop solutions to a major world problem. The members of Amalgamated have been unable to reach agreement on which problem to address first. They have selected you to identify the problem most crucial to the future of the people of earth. To insure that no single member of their group can influence your work, the only information they have provided is a packet of maps.

1. Study the maps carefully.

2. Identify *five* world problems caused by geography.

3. Discuss each problem you have identified and decide which problem, if solved, would have the greatest positive impact on the people of the world.

4. Develop a written "Solution Proposal." The proposal should include a clear statement of the problem and a discussion of who will do what, when, where, and how to alleviate the problem. Prepare maps, charts, or other drawings to use in your presentation to the Amalgamated board. You may propose the development of new technologies, but you must base those technologies on the realities of today's technology. You will have five to seven minutes to make your presentation.

As you prepare, remember that you have vast economic, technical, and intellectual resources available. Still, the Amalgamated board will be most interested in a proposal that is quick to implement, relatively inexpensive, and obviously effective.

PRESENTATION EVALUATION FORM

	Poor	Adequate	Good	Excellent
Group #				
Importance of the problem				
Adequacy of the solution				
Creativity of the proposal				
Persuasiveness of the proposal				
Overall				

Comments:

	Poor	Adequate	Good	Excellent
Group #				
Importance of the problem				
Adequacy of the solution				
Creativity of the proposal				
Persuasiveness of the proposal				
Overall				

Comments:

16. IT'S A NATURAL!

Introduction:

Americans seem to be increasingly health conscious. Eating patterns have changed, as "natural" foods have gained in popularity. Food producers have been quick to recognize and follow that trend. New foods, as well as new styles of existing products (flavored yogurt, light beer), have appeared. In this lesson students examine the validity of some health food claims.

This activity makes a good introduction to a unit on government control of industry and/or one on advertising techniques. It will work best if you begin discussion on a Friday so that students will have time over the weekend to collect samples for the homework activity.

Objectives: Students will be able to:

1. Give examples of "natural" foods, both processed and unprocessed.
2. Identify ingredients used in food products.
3. Critically evaluate advertising claims.
4. Value the knowledge and skills of a nutritionist.

Subject/Grade Level: Current events/grades 7-12; economics/grade 12, life science/grade 7, general science/grade 9; chemistry/grade 11

Time Required: 1-2 class periods plus homework time

Materials and Preparation: Two weeks prior to the class, arrange for a nutritionist to speak to the class. The school district, a local hospital, or a restaurant chain are all possible sources for speakers. Provide the speaker with a copy of this lesson so he/she will understand the objectives of the class visit. Encourage the speaker to provide visuals and involve students actively in the session.

Procedures:

1. Start by having students think of their favorite foods. Across the top of the chalkboard, write these three column headings—I, II, III. The columns represent these categories: I = "natural" or unprocessed foods; II = foods subjected to some processing; III = substantially processed foods. Do not reveal what the categories are yet. Ask students to call out their foods. As they contribute, write the items in the appropriate categories. The exact categorization is not critical, but as a guideline, category I would include those foods sold and eaten with nearly no processing, such as lettuce or potatoes. Category II foods would be slightly more processed—apples might fit here, as they are waxed and polished before sale; oranges are also dyed and waxed. Category III contains nearly all canned or bottled foods.

2. After recording 20 to 30 foods, have students decide how they would label each category. What do the foods in each column have in common that might provide a good label? Students will probably propose a wide range of labels, some of which will be quite appropriate. Validate those contributions by exploring student perceptions of why those labels might work. Finally, add the labels you had in mind. Note how they agree/diverge from student proposals.

3. Ask students what criteria they would use to distinguish between categories I and II. How "processed" can a food be and still be "natural"? What does "processed" mean? What is "natural"?

4. Next, ask students what products they can think of that claim in their advertising to be "natural." How believable is that claim? Why would advertisers make that claim? What products do you buy because they are "natural"?

5. Assign the homework project. Students are to find two foods that are advertised as "natural" or as containing only "natural ingredients." Students should either write down all the ingredients or bring the labels into class on Monday. Another option is for students to videotape an evening of television and extract any commercials promoting natural products. The actual labels for those products should be found and compared to the advertising. Students should indicate, in writing, whether each product deserves the "natural" label and whether they would recommend buying the product.

6. At the beginning of the next class period, have students share their discoveries and concerns.

7. Reserve the balance of the period for the guest speaker.

Evaluation:

The homework assignment can be used to evaluate student achievement of the objectives for the lesson. While the nutritionist is speaking, you might keep track of the number and quality of questions students ask as a further indication of their learning.

Extension/Enrichment:

Some "fast-food" chains publish and distribute, free of charge, booklets with nutritional information for their products. These booklets, as well as materials from the Council on Nutrition, *Prevention* magazine, and resources from home economics instructors, are potential sources for further research into American eating habits.

17. FURROWS TO THE FUTURE

Introduction:

Developments in agricultural technologies have enabled humans to produce a surplus of food. The abundance of food freed some workers to specialize in other types of labor and eventually led to the growth of cities. Relatively small advances in technology thus greatly affected society. This lesson examines changes in plow technology that resulted in increased food production.

Objectives: Students will be able to:

1. Describe some significant developments in agricultural technologies.

2. Organize and present data in different ways.

3. Appreciate the importance of farming to modern life.

Subject/Grade Level: World geography or history/grade 7; U.S. history/grades 8, 11; life science/grade 7

Time Required: 3 class periods

Materials and Preparation: Make copies of Handouts 17-1 and 17-2 for all students. Students will also need poster paper and markers. Collect a variety of information sources on farming or insure that they are available in the library. *National Geographic* articles are especially helpful (see. for example, the September 1984 issue).

Procedures:

1. Pass out Handout 17-1. Discuss briefly the importance of farm machinery in contemporary Western farming. Allow students about five minutes to arrange the plow illustrations in chronological order:

D—3000 B.C. Egyptian

E—1000 A.D. Northwestern Europe

C—1900 A.D. American/European

B—1940 A.D. American

A—1987 A.D. Experimental American (A special blade travels horizontally just under the soil surface while twisted steel shanks dig deeply into the soil. This allows more effective weedkilling and greater water retention.)

2. Have students keep their papers while the answers are discussed. Ask the following questions:

- What does plowing do? (Breaks up the soil.) Why is that important? (Easier to plant; soil retains more water; kills weeds)
- What clues in the drawings helped you decide the order of development?
- How else might we group, or arrange, these plows? (By materials used to make them; by size; by method of propulsion; by probable size of the fields plowed by each; by area of origin)

- What is the main material used to construct plow D? (Wood) Plow C? (Steel) How did the change from wooden to steel plows affect the process of plowing? (Deeper furrows; could plow rockier land; sharper and thus faster; stronger and lasted more years)
- What is one major difference between plow D and plow E? C and E? A and B? What do these changes tell you about the rest of society?

3. Divide the class into groups of four. Distribute Handout 17-2 and review the directions for the poster activity.

4. The following day, reconvene the groups and check for understanding of the directions. Direct groups to the research materials and allow the rest of the period for research and work on the posters. Allow a few minutes the following day for groups to complete the posters.

5. Have each group present its findings by explaining its posters.

Evaluation:

You may assign group grades on the basis of the posters and presentation or may ask students to write a brief evaluation of another group's posters, their analyses of their classmates' work should indicate their understanding of the influence of technology.

Extension/Enrichment:

Local farmers' organizations may have speakers available to discuss various aspects of farming, from technology and labor to financial and political issues. Another effective poster project is to assign each group a piece of agricultural technology from a particular era or geographical area (allowing students to compare farming practices around the world). Each group researches its item or area and produces a poster. The posters can be illustrated in chronological order to show change over time.

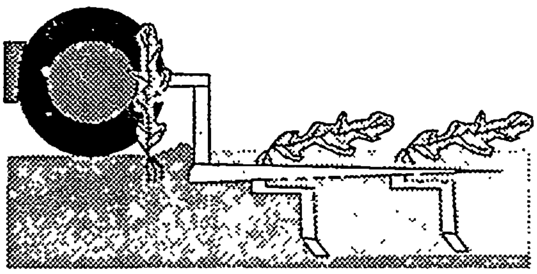
Resources:

Killengray, Margaret, *The Agricultural Revolution* (St. Paul, Minnesota, Greenhaven Press, 1980).

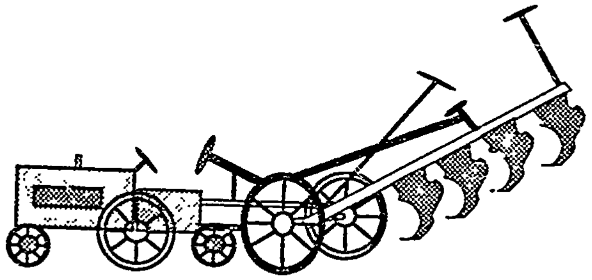
National Geographic (September 1984).

White, Lynn, Jr., *Medieval Technology and Social Change* (London. Oxford University Press, 1964).

PLOWS THROUGH HISTORY



A.



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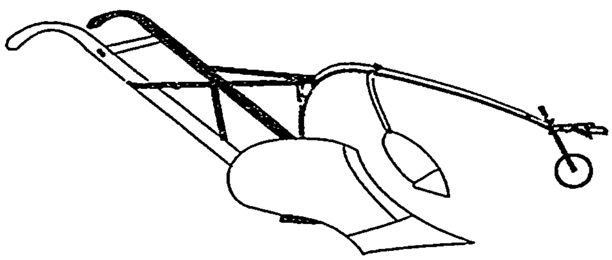
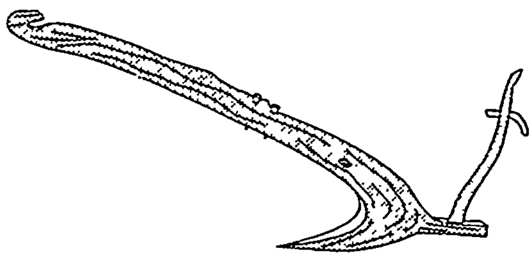


C.



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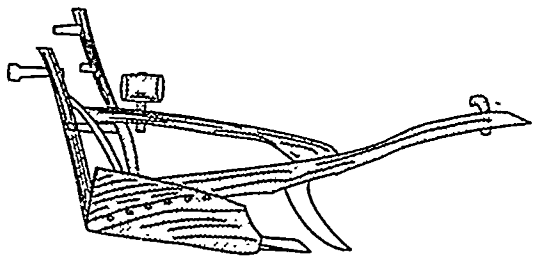


E.

POSTER ASSIGNMENT SHEET

Agriculture forms the essential base of civilization. Complex societies, regardless of their technological achievements, must first produce enough food to feed their people. The development of the plow helped insure that sufficient food was available to feed the non-farming city dwellers.

Your groups is to explore the effects improved farm technology had on society. Divide these questions among your group members and search for the information in magazines, encyclopedias, and other books. When you have completed your research, transfer your information to a poster. On a second poster, use your research to predict the future of farming and its effects on society.

Questions to research for Poster #1:

1. How did the invention of the plow change farming?
2. How did the invention of the plow change the size of the fields?
3. How did the invention of the plow change the number of hours each farmer worked?
4. How did the invention of the plow change the amount of food produced? Why?
5. How did the cost of farm machinery change? Why?
6. How has technology affected the number of farms?
7. How has technology affected the price of food?
8. How has technology affected the quality of food?
9. How has technology affected the availability of food?
10. How has technology affected the ways food is sold?
11. How has technology affected family life?
12. What other technologies and sciences developed that had effects on farming?

Questions to research for Poster #2:

1. What will the farm of the future look like?
2. What technologies will the farm of the future have?
3. How will changes in farms affect society?

18. PEOPLE AND MACHINES

Introduction:

Much of the increase in the use of energy in the United States has been due to the use of powered machinery. The use of machinery has increased the productivity of human labor and thereby eliminated jobs (of course, often creating other jobs and lowering the price of the goods produced). Thus, mechanization presents a continuing social dilemma. Examining the perceptions and impact of mechanization on two different American farmers can provide students with perspectives on this problem.

Objectives: Students will be able to:

1. Give examples of how the use of power-driven machinery can eliminate jobs.

2. Describe the relationship of mechanization to the availability of other opportunities for workers.

3. Describe how changes in technology affect lifestyles in both positive and negative ways.

4. Write a paragraph defending a position.

5. Understand varying attitudes toward technology.

Subject/Grade Level: World geography/grade 7, U.S. history/grade 8; sociology/grade 12, economics/ grade 12

Time Required: 1 class period

Materials and Preparation: Make enough copies of Handouts 18-1 and 18-2 for half the class. Make copies of Handout 18-3 for all students. If possible, find a picture of an early thrasher to display.

Procedures:

1. Ask students if they have ever heard their parents or other adults speak negatively about technology, especially technology that they use on their jobs. Why do some adults react this way to changes in the ways things are done, while others are excited about using any new machine that comes along? Tell students that throughout history, people have reacted both positively and negatively to new machines and methods. In this lesson, they will be reading about how two farmers felt about a new farm technology used to separate grain from its hull. If one is available, display and discuss a picture of an early thrasher.

2. Divide the class into two groups. Distribute Handout 18-1 to one group and Handout 18-2 to the other group. Distribute Handout 18-3 to all students. Students should read carefully to understand the technologies used by each farmer. As they read, they should fill out the "Comparing Technologies" chart. The questions at the bottom of the sheet will be answered after both groups have discussed their readings. Allow ten minutes for the students to read.

3. Bring the class to attention. First, ask various students to describe Mr. Ingalls' method of threshing. Students in the "Wilder" group should take notes on their charts. Next, debrief the Wilder group in the same manner.

Source. Adapted from *Teaching About Energy*, "Unit 6. Energy in the United States" (Santa Monica, CA: Enterprise for Education, 1984). Used by permission of the publisher.

4. Allow students five to ten minutes to answer the questions at the bottom of the chart.

Evaluation:

The questions at the bottom of Handout 18-3 can be used for evaluation purposes.

Extension/Enrichment:

Encourage students to expand their knowledge of mechanization by researching the development of one technology and the changes it produced in the society. They can present their findings in an illustrated report or poster. Students might read additional books by Laura Ingalls Wilder to look for information on other new technologies of the era.

MR. INGALLS THRESHES

In this passage from *Little House in the Big Woods*, Laura Ingalls Wilder describes how a new machine came to thresh the wheat. Threshing separates the kernels of wheat from the wheat stalk and removes the chaff, a hull around each kernel. The wheat berries that are left are then ready to be ground into flour.

One frosty morning, a machine came up the road. Four horses were pulling it, and two men were on it. The horses hauled it up into the field where Pa and Uncle Henry and Grandpa and Mr. Peterson had stacked their wheat.

Two more men drove after it another, smaller machine.

Pa called to Ma that the threshers had come; then he hurried out to the field with his team. Laura and Mary asked Ma, and then they ran out to the field after him. They might watch, if they were careful not to get in the way.

Uncle Henry came riding up and tied his horse to a tree. Then he and Pa hitched all the other horses, eight of them, to the smaller machine. They hitched each team to the end of a long stick that came out from the center of the machine. A long iron rod lay along the ground, from this machine to the big machine.

Afterward Laura and Mary asked questions, and Pa told them that the big machine was called the separator, and the rod was called the tumbling rod, and the little machine was called the horsepower. Eight horses were hitched to it and made it go, so this was an eight-horsepower machine.

A man sat on top of the horsepower, and when everything was ready he clucked to the horses, and they began to go. They walked around him in a circle, each team pulling on the long stick to which it was hitched, and following the team ahead. As they went around, they stepped carefully over the tumbling rod, which was tumbling over and over on the ground.

Their pulling made the tumbling rod keep rolling over, and the rod moved the machinery of the separator, which stood beside the stack of wheat.

All this machinery made an enormous racket, rackety-banking and clanging. Laura and Mary held tight to each other's hand, at the edge of the field, and watched with all their eyes. They had never seen a machine before. They had never heard such a racket.

Pa and Uncle Henry, on top of the wheat stack, were pitching bundles down on to a board. A man stood at the board and cut the bands on the bundles and crowded the bundles one at a time into a hole at the end of the separator.

The hole looked like the separator's mouth, and it had long, iron teeth. The teeth were chewing. They chewed the bundles and the separator swallowed them. Straw blew out at the separator's other end, and wheat poured out of its side.

Two men were working fast, trampling the straw and building it into a stack. One man was working fast, sacking the pouring grain. The grains of wheat poured out of the separator into a half-bushel measure, and as fast as the measure filled, the man slipped an empty one into its place and emptied the full one into a sack. He had just time to empty it and slip it back under the spout before the other measure ran over.

All the men were working as fast as they possible could, but the machine kept right up with them. Laura and Mary were so excited they could hardly breathe. They held hands tightly and stared.

The horses walked around and around. The man who was driving them cracked his whip and shouted, "Giddap there, John! No use trying to shirk!" Crack! went the whip. "Careful there, Billy! Easy, boy! You can't go but so fast nohow."

The separator swallowed the bundles, the golden straw blew out in a golden cloud, the wheat streamed golden-brown out of the spout, while the men hurried. Pa and Uncle Henry pitched bundles down as fast as they could. And chaff and dust blew over everything. Laura and Mary watched as long as they could.

Then they ran back to the house to help Ma get dinner for all those men.

A big kettle of cabbage and meat was boiling on the stove; a big pan of beans and a johnny-cake were baking in the oven. Laura and Mary set the table for the threshers. They put on salt-rising bread and butter, bowls of stewer pumpkin, pumpkin pies and dried berry pies and cookies, cheese and honey and pitchers of milk.

Then Ma put on the boiled potatoes and cabbage and meat, the baked beans, and hot johnny cake and the baked Hubbard squash, and she poured the tea. At noon the threshers came in to the table loaded with food. But there was none too much, for threshers work hard and get very hungry.

By the middle of the afternoon the machines had finished all the threshing, and the men who owned them drove them away into the Big Woods, taking with them the sacks of wheat that were their pay. They were going to the next place where neighbors had stacked their wheat and wanted the machines to thresh it.

Pa was very tired that night, but he was happy. He said to Ma:

"It would have taken Henry and Peterson and Pa and me a couple of weeks apiece to thresh as much grain with flails as that machine threshed today. We wouldn't have got as much wheat, either, and it wouldn't have been as clean.

"That machine's a great invention!" he said.

"Other folks can stick to old-fashioned ways if they want to, but I'm all for progress. It's a great age we're living in. As long as I raise wheat, I'm going to have a machine come and thresh it, if there's one anywhere in the neighborhood."

He was too tired that night to talk to Laura, but Laura was proud of him. It was Pa who had got the other men to stack their wheat together and send for the threshing machine, and it was a wonderful machine. Everybody was glad it had come.

MR. WILDER THRESHES

In the book *Farmer Boy*, Laura Ingalls Wilder describes the boyhood of the man she eventually married, Almanzo Wilder. Almanzo grew up on a prosperous farm in upper New York State near the Saint Lawrence River. This region had been settled for several hundred years, and the Wilder family's life represented up-to-date conventional farming, not pioneering the wilderness. Almanzo's father didn't share Mr. Ingalls' feeling about threshing machines.

The flail had come off its handle and Father had put them together again. The flail was an ironwood stick, three feet long and as big around as a broomhandle. It had a hole through one end. Its handle was five feet long, and one end was a round knob.

Father put a strip of cowhide through the hole in the flail, and riveted the ends together to make a leather loop. He took another strip of cowhide and cut a slit in each end of it. He put it through the leather loop on the flail, then he pushed the slits over the knobbed end of the handle.

The flail and its handle were loosely held together by the two leather loops, and the flail could swing easily in any direction.

Almanzo's flail was just like Father's, but it was new and did not need mending. When Father's flail was ready, they went to the South-Barn Floor.

There was still a faint smell of pumpkins, though the stock had eaten them all. A woodsy smell came from the pile of beech leaves, and a dry, strawy smell came from the wheat. Outside the wind was screeching and the snow was whirling, but the South-Barn Floor was warm and quiet.

Father and Almanzo unbound several sheaves of wheat and spread them on the clean wooden floor.

Almanzo asked Father why he did not hire the machine that did threshing. Three men had brought it into the country last fall, and Father had gone to see it. It would thresh a man's whole grain crop in a few days.

"That's a lazy man's way to thresh," Father said. "Haste makes waste, but a lazy man'd rather get his work done fast than do it himself. That machine chews up the straw till it's not fit to feed stock, and it scatters grain around and wastes it.

"All it saves is time, son. And what good is time, with nothing to do? You want to sit and twiddle your thumbs, all these stormy winter days?"

"No!" said Almanzo. He had enough of that, on Sundays.

They spread the wheat two or three inches thick on the floor, Then they faced each other, and they took the handles of their flails in both hands; they swung the flails above their heads and brought them down on the wheat.

Father's struck, then Almanzo's, then Father's, then Almanzo's. Thud! Thud! Thud! Thud! It was like marching to the music on Independence Day. It was like beating the drum. Thud! Thud! Thud! Thud!

The grains of wheat were shelling from their little husks and sifting down through the straw. A faint, good smell came from the beaten straw, like the smell of the ripe fields in the sun.

Before Almanzo tired of swinging the flail, it was time to use the pitchforks. He lifted the straw lightly, shaking it, then pitched it aside. The brown wheatgrains lay scattered on the floor. Almanzo and Father spread more sheaves over it, then took up their flails again.

All that day the pile of wheat grew higher. Just before chore-time Almanzo swept the floor in front of the fanning-mill. Then Father shoveled wheat into the hopper, while Almanzo turned the fanning-mill's handle.

The fans whirred inside the mill, a cloud of chaff blew out its front, and the kernels of clean wheat poured out of its side and went sliding down the rising heap on the floor. Almanzo put a handful into his mouth; they were sweet to chew, and lasted a long time.

He chewed while he held the grainsacks and Father shoveled the wheat into them. Father stood the full sacks in a row against the wall—a good day's work had been done.

COMPARING TECHNOLOGIES

	Ingalls	Wilder
Method of threshing		
Time spent		
Amount of grain threshed		
Grain or straw wasted		
Hand tools used		
Other machines used		
Animal labor used		

Wait until after the discussion to answer the questions below.

1. Why do people mechanize their work?
2. How did Mr. Wilder feel about mechanization? Why?
3. What changes might the threshing machine have made in the lives of wheat farmers?
4. Write a five-sentence paragraph that tells why you agree with either Mr. Ingalls or Mr. Wilder. Be sure to proofread your paragraph to check spelling, grammar, and sentence structure.

19. DOING SOMETHING ABOUT THE WEATHER

Introduction:

Weather modification by "cloud seeding" creates a variety of conflicts. Rain needed by one group of people may be disastrous for another. Downwind people may be deprived of rain they might otherwise have received. In this lesson students explore these issues through court case simulations. They write model laws for the regulation of cloud seeding.

Objectives: Students will be able to:

1. Describe the purposes of cloud seeding.

2. List social problems caused by cloud seeding.

3. Take and defend a position on issues raised by cloud seeding.

4. Appreciate the importance of policies for dealing with science-related social issues.

Subject/Grade Level: U.S. history/grade 11; government/grade 12; civics/grade 9; economics/grade 12; current events/ grades 9-12; chemistry/grade 11; physics/grade 12

Time Required: 3 class periods

Materials and Preparation: Make four or five copies of each case, as well as copies of Handouts 19-1 and 19-2 for all students. Make overhead transparencies of the decision options for each case. Check with a local research library or environmental group for information on state weather modification laws. You will also need poster paper, markers, and an overhead projector.

Procedures:

1. Remind students that technology now allows people to control weather, to some extent, by seeding clouds to produce rain. Have students brainstorm a list of problems cloud seeding might solve and a list of the problems it might create. Tell students they will be exploring some of the latter problems in this lesson.

2. Divide the class into five groups. Distribute a different case to each group. Allow about 15 minutes for students to discuss their cases and reach decisions. Inform students that they will be making five-minute presentations to the class, in which they must persuade students of the correctness of their decision.

3. Distribute Handout 19-1, explaining that students should take notes on the content of each case and the decision. Project the "Decision Options" overhead for the first group and allow time for students to read through it.

4. Turn off the projector and have the first group begin its presentation. Following the presentation, have the class vote on an outcome. If the presenters have explained their reasoning clearly, the class may be persuaded to select the same outcome as the group. Groups that are successful in gaining support for their decisions may be rewarded through grades or your favorite alternative reward system. Allow time for students to record the essence of the decision on their handouts.

Source: Adapted from *People and Environmental Changes*, one of 12 modules in the series *Science-Technology-Society: Preparing for Tomorrow's World* (Longmont, CO. Sopris West, 1982). Used by permission of the publisher. For more information, call 303/651-2829.

5. Use the same procedure for each of the remaining groups. As students complete their notes on the handout for the last group, write this assignment on the board:

Homework

Based on the court cases we have just reviewed, write one generalization for each of these items.

- The effectiveness of cloud seeding
- The legality of cloud seeding
- The necessity for cloud seeding
- The dangers of cloud seeding

6. The following day, collect the homework. Briefly discuss student findings.

7. Reconvene the groups and distribute Handout 19-2. Allow the rest of the period for discussion and writing. The last five minutes should be spent posting the laws on the posting paper.

8. Reconvene the groups the following day. Allow five minutes for groups to complete work and prepare their oral presentations on their proposed laws.

9. After all presentations have been made, see if duplicate or similar laws can be eliminated or combined.

10. If time permits, compare the student-developed laws with state laws. As an alternative, you may wish to have students do this as an extension activity.

Evaluation:

The two group presentations and homework assignment can be used to evaluate student learning. Asking each student to write a defense of his/her preferred law would also be a useful assessment exercise.

Extension/Enrichment:

Have students find out if any cloud seeding is done in your community.

THE CENTER CITY FLOOD

Center City experienced its worse storm in history in December 1955. The levees above the town gave way. Flood waters poured in, killing 37 persons, injuring over 3,000, destroying 450 homes and damaging 6,000 more. Losses ran into the hundreds of millions of dollars.

Who was to blame and how could damages be recovered? Was it the fault of town officials who failed to evacuate the town? Were the levees not properly maintained by the country?

Investigating all possible causes for the disaster, the town officials learned that the state's largest electric company had been operating rainmaking equipment in ten sites around the area. The purpose was to increase the snowpack in the mountains and thereby increase the water supply to run its electricity generators. The town officials concluded that rainmaking had increased the normal amount of rainfall. The added rain filled the river to capacity, soaked the soil, and weakened the levees.

The town then sued the electric company, contending that it was liable for the losses suffered by Center City residents. Mr. Marks, lawyer for the electric company, questioned a company representative.

Mr. Marks: How long have you been cloud seeding in the area and what were the results?

Company Representative: For two years. Most of the rain and snow we made ran into Lake Thoms. We increased rain in our target area by 26 percent. But, Lake Thoms had never spilled over.

Mr. Marks: Did you seed prior to the storm, and did you seed those particular storm clouds?

Company Representative: Yes, we seeded the first part of the week but turned off the generators the day before the storm because the clouds were too high to be reached with our ground generators.

Mr. Marks: Did you have approval to conduct the cloud seeding?

Company Representative: Yes, we were granted permission by the state.

Mr. Nils, lawyer for the town, questioned Mr. Moore, a weather expert.

Mr. Nils: What were the weather conditions just before the storm?

Mr. Moore: Snow and rainfall for the first half of the month broke all previous records, but high temperatures in the mountains melted 30 inches of snow in three days.

Mr. Nils: Could the silver iodide, generated the day before, have reached the storm clouds?

Mr. Moore: Maybe. But most of the rain would have fallen over the area draining into Lake Thoms, 50 miles away.

How did the court decide? What reasons did it give for that decision?

A. Yes, the company is liable because it should not be tampering with the weather.

B. No, the company is not liable because that storm was an act of God.

C. Yes, the company is liable because the area never had so much rainfall.

D. No, the company is not liable because there is no proof that seeding affected the storm.

ROBBING PETER TO PAY PAUL (OR WHO HAS THE RIGHT TO THE CLOUDS ABOVE?)

Paul, a wheat farmer in Texas, joined with neighboring wheat farmers to hire the firm, Weather Changers, to conduct hail-suppressing operations during the farming season. The year before, severe hail storms had damaged crops so badly that farmers lost over half the harvest. The farmers felt that they could not take such a chance again. Another bad year and they might all be out of business.

For a year, cloud-seeding operations were conducted over the entire area. The number of hail storms was reduced, and the farmers enjoyed a good wheat harvest. Peter, a neighboring rancher to the northeast, however, was left with dry and sparse grass that year. He was forced to spend several thousand dollars to buy grain to feed his cattle. He felt that the cloud seeding had robbed him of the normal rainfall necessary to keep his grasses green and animals fed.

Peter went to court to ask that it issue a ban on all future cloud-seeding activities in the area.

How did the court decide? What reasons did it give for that decision?

A. The farmers may continue to seed clouds because there is no law stating that they cannot.

B. The farmers must stop seeding because the ranchers have a right to the rainfall nature provides over their land.

C. The farmers may continue to seed because they have a right to protect their crops.

D. The farmers must stop seeding because they are causing harm to the ranchers.

FILLING THE CITY RESERVOIR

City X, the largest city on the east coast with over 10 million people, was suffering a severe water shortage. There had been no winter snow, and spring rains were sparse. Pure drinking water from its mountain reservoir had reached a critically low point. The city hired Dr. Hone to seed the clouds as they passed by the mountains in order to raise the water level of the reservoir. After the seeding operations, the reservoir gained a two-week supply of water.

This brought immediate relief to the city residents, but Mr. Sax was most displeased. He owned a large fancy resort in the mountains. Because of the rains, his resort was deserted. Each day of rain caused him to lose thousands of dollars. His business depended on good summer weather.

Mr. Sax went to court to ask that the seeding operations be ordered stopped. He pointed out that the unexpected summer rains harmed his resort business. In addition, the increased amounts of rain might overflow the mountain streams, causing possible property damage to people living along the stream.

How did the court decide? What reasons did it give for that decision?

A. City X may continue to seed clouds because water is important to the welfare of the general public.

B. City X may not continue to seed clouds because it does not have a right to disturb clouds over someone else's property.

C. City X may continue to seed clouds because there is no evidence that the rains will cause flooding. (speculative nature of risk)

D. City X may not continue to seed clouds because it will be taking rain away from other areas.

NOT ENOUGH RAIN

Tom Hayes was assured by Rainfall Inc. that cloud seeding would solve all his worries over the drought forecast for that year. He paid the company $5,000 to seed clouds over his farm for the season and then went ahead and planted all his wheat fields.

Whenever the clouds passed by, company planes flew over and seeded. Sometimes rain fell, and other times it did not. By the middle of summer, the wheat was wilting from the heat and lack of water.

Tom was furious. This was not what he expected. Now his huge investment of seed, fertilizer, and extra hired help was "going down the drain"! How was he to recover such a great loss?

He felt that Rainfall Inc. had led him astray with its promise. He went to court to demand a refund on the payment as well as money to compensate for his crop loss.

In court, Rainfall Inc. argued that it did not promise with absolute certainty that Tom would reap an abundant harvest. It did not sign an agreement to deliver so many gallons of water. "Anyway," said the company representative, "controlling weather is tricky business; you cannot always predict that all clouds will behave in the same way. Under some conditions no matter what you do, rain cannot be produced. It is like trying to wring water out of a dry sponge."

Tom's lawyer, on the other hand, contended that the company had misrepresented itself by making claims that it could avert the drought. Tom trusted its judgment and therefore went ahead with his plans.

How did the court decide? What reasons did it give for that decision?

A. Rainfall Inc. must return the money because it didn't know what it is doing and shouldn't be in the business.

B. Rainfall Inc. need not return the money because it performed the services agreed upon.

C. Rainfall Inc. must return the money because it claimed that cloud seeding would solve the problem of insufficient rainfall.

D. Rainfall Inc. need not return the money because there is not enough proof that it was trying to cheat Tom.

SCIENTIFIC UNCERTAINTY

"Cloud seeding is still an experiment," reported Dr. Bruce, "and more experiments are needed before we can say with certainty how much we truly benefit from cloud seeding. Will cloud seeding benefit one area to the detriment of another? I recommend that we conduct experiments over a larger area and for a longer time period. In this way we can begin to learn more about the behavior of different types of clouds and how different seeding materials might affect the outcome of a storm."

In response to Dr. Bruce's report, three adjoining states organized a hail suppression program. In the study they would compare crop production in areas where hail storms are seeded to areas where this is not done. They would also study different cloud seeding methods and materials and gather information about different cloud types and on how to select clouds for seeding. A tri-state weather study committee was formed to select the areas for the test and those areas to be left as control and to design the procedures to be used.

A year after the program began, a survey of the crop harvest in the seeded areas showed a 25 percent reduction in crop loss. This certainly pleased the farmers in the area. But, farmers who were not in the seeded area felt that they had been cheated out of the possible benefits.

The farmers in the unseeded area brought their case to court and demanded that the state government pay them for what they lost in crop damages. They argued that it was unfair that they be "guinea pigs" in the experiments. "Why should we be left out of the benefits? The experiment was paid for through our taxes, yet we had not been given an opportunity to participate. The study committee merely selected the areas in an arbitrary way."

How did the court decide? What reasons did it give for the decision?

A. The state governments are not responsible for the damages because hail storms are a natural occurrence. Farmers have accepted that fact even before cloud seeding became available.

B. The state governments are responsible because they could have helped the farmers if they wanted to.

C. The state governments are responsible because they must insure that the people involved are adequately protected when they take on a project of such an experimental nature.

D. The state governments are not responsible because there was no guarantee that the seeded areas would benefit significantly.

CASE 1

CENTER CITY FLOOD

A. Yes, the company is liable because it should not be tampering with the weather.

B. No, the company is not liable because that storm was an act of God.

C. Yes, the company is liable because the area never had so much rainfall.

D. No, the company is not liable because there is lack of proof that seeding had a direct effect on the disastrous storm.

CASE 2

ROBBING PETER TO PAY PAUL

A. The farmers may continue to seed clouds because there is no law stating that they cannot.

B. The farmers must stop seeding because the ranchers have a right to the rainfall nature provides over their land.

C. The farmers may continue to seed because they have a right to protect their crops.

D. The farmers must stop seeding because they are causing harm to the ranchers.

CASE 3

FILLING THE CITY RESERVOIR

A. City X may continue to seed clouds because water is important to the welfare of the general public.

B. City X may not continue to seed clouds because it does not have a right to disturb clouds over someone else's property.

C. City X may continue to seed clouds because there is no evidence that the rains will cause flooding. (speculative nature of risk)

D. City X may not continue to seed clouds because it will be taking rain away from other areas.

CASE 4

NOT ENOUGH RAIN

A. Rainfall Inc. must return the money because it didn't know what it is doing and shouldn't be in the business.

B. Rainfall Inc. need not return the money because it performed the services agreed upon.

C. Rainfall Inc. must return the money because it claimed that cloud seeding would solve the problem of insufficient rainfall.

D. Rainfall Inc. need not return the money because there is not enough proof that it was trying to cheat Tom.

CASE 5

SCIENTIFIC UNCERTAINTY

A. The state governments are not responsible for the damages because hail storms are a natural occurrence. Farmers have accepted that fact even before cloud seeding became available.

B. The state governments are responsible because they could have helped the farmers if they wanted to.

C. The state governments are responsible because they must insure that the people involved are adequately protected when they take on a project of such an experimental nature.

D. The state governments are not responsible because there was no guarantee that the seeded areas would benefit significantly.

DECISION RECORD SHEET

	Notes	Decision
Case 1: Center City Flood		
Case 2: Robbing Peter to Pay Paul		
Case 3: Filling the City Reservoir		
Case 4: Not Enough Rain		
Case 5: Scientific Uncertainty		

WHAT SHOULD BE THE LAW?

From the court cases, you no doubt came to realize that weather modification by "cloud seeding" creates a variety of conflicts. Rain needed by one group of people may not be needed by another group in the same area. If clouds are seeded to produce more rain in one section of the country, the section downwind may find their rainfall reduced. A number of questions thus arise:

- Can people "own" the moisture in the air in the same sense as they own property?
- Does one have the right to the clouds above one's property or just the rain that falls on the property?
- How might people be protected from harmful effects of cloud seeding?
- How does one decide if people in one area are harmed by cloud seeding in another area?
- How does one decide that increasing rainfall or suppressing hail is necessary?

At present, the laws regulating rain-making are not clear. Some states have rain-making regulations; others do not. A few have even banned rain-making altogether. For examples:

- State X claims that all moisture in the atmosphere above it belongs to the people of the state. Therefore private parties, in order to seed clouds, must show that their activity will not be harmful to the people of the state.
- State Y allows each county to set its weather modification regulations, and each has a right to prohibit that activity if it finds it undesirable.
- State Z puts no limits on weather modification activities and only requires that persons or companies involved in cloud seeding file a report on their activities.

In this activity you will have the opportunity to write a set of four laws governing weather modification activities for a state. The characteristics of the state and guidelines for writing the laws are described below:

Law for Rain-making in State A:

State A is primarily an agricultural state and frequently has long periods of drought that result in hundreds of millions of dollars in crop loss. In times of scarce rainfall, it needs to buy water from a neighboring state for irrigation and drinking, but that state has had an increase in population and is less willing to sell its water.

State A has no laws that regulate weather modification. In teams of four to five students, write a set of laws for State A that will govern weather-changing activities and will adequately settle the legal questions and problems that might arise.

Considerations:

First determine who owns moisture in the air. Does it belong to all the people of the state as "common property" or to the people who own the land underneath the air? If the moisture in the air is held by everyone in common, does it mean that the state can tell the property owner how much of the water that falls on his/her land he/she is allowed to use? If the moisture in the air above belongs to the property owner, does he/she have the right to make rain whenever he/she pleases even though it might have undesirable effects on his/her neighbors? Explain why you have selected your particular viewpoint.

Should the state control all weather modification activities or should this be left to private operators?

- If activities are conducted by private operators, how does one determine if the weather changers are competent?

- If the state government conducts the activities, how does it select "where" and "when" to cloud seed? What government agency should make the selections? Increased rain may not please everyone who is affected. A government agricultural agency's interest in changing the weather may be different from that of the government transportation agency.

If the rain-making causes damages, who should be held responsible?

- How does one determine if damage has occurred? If rain, for example, spoils a large outdoor festival, is that to be considered an important loss?
- Who determines what is a harm or a damage? A benefit to one party may not be considered a benefit by the other party. (Heavy snowfall is welcomed by ski resort owners, but not necessarily by city governments, which must spend large sums of money for snow removal.) If one area loses rainfall, how can its residents recover the loss?
- Does one have to show that harm has been done to recover the loss? How does one prove that harm has occurred? (Is there any way that one can prove that a cloud-seeding activity significantly reduced rainfall in another area or that it increased the severity of the storm rather than decreased it?)

If cloud-seeding activities were operated by the state, who should pay for them? Everyone? Only those who benefit?

- How will the state show that it is acting in everyone's best interest? What if errors occurred in the cloud-seeding procedure and damage to property and lives resulted?

To aid in the development of the final set of laws, it would be helpful to group the laws into categories as they are presented. Some possible categories might include:

- Cloud seeding operators
- Types of permissible activities
- Management of activity
- Role of state government
- Liability rules (Who is responsible? What types of damages can be claimed?)
- Agreements between states

The Complete Weather Modification Laws for State A:

Examine each law in turn, and as a group decide if the law should be included in the final set of laws. In making the decision, determine if the law satisfies the following points:

- Does the law treat everyone fairly?
- Does the law violate anyone's rights unnecessarily?
- Are people and their property adequately protected?

Compile the set of laws for State A. Examine them as a whole. Determine if any regulations conflict with others and make the necessary changes.

Procedure:

Meet in your groups to discuss the above considerations and select a recorder to write down the main ideas brought out.

Begin by listing all the possible problems that you think might arise in weather modification activities. For example, How are different people affected? What might be their objections? On what grounds might they base their objections? It may be helpful to refer to the court cases for some ideas.

Using the list of possible problems as a guide, develop a set of laws/regulations for weather modification activities in State A. The laws that you write should help to settle some of these possible problems.

When each group has completed its set of weather modification laws, all class members will meet together. At this time, a spokesperson from each group will present the laws developed by the group.

20. SIMULATING THE STRATEGIC DEFENSE INITIATIVE

Introduction:

The Strategic Defense Initiative (SDI) is the Reagan administration's proposal for using a space-based defense system for the United States. The program has been widely hailed and widely assailed. To help make the proposed project understandable to citizens, a variety of greatly simplified models have appeared. This lesson examines one model, asking students to critically assess the assumptions, operations, and conclusion resulting from that model.

Objectives: Students will be able to:

1. Describe the goals of the Strategic Defense Initiative.

2. Analyze a simplified model of the SDI, examining the values and assumptions underlying the model.

3. Appreciate the necessity for a technologically literate society.

Subject/Grade Level: U.S. history/grade 11; government/grade 12; current events/grades 10-12

Time Required: 2 class periods

Materials and Preparation: Make copies of Handout 20-1 for all students. You may find it helpful to do some background reading on SDI before teaching the lesson.

Procedures:

1 Briefly describe the basic notion of the Strategic Defense Initiative. Ask students what students have heard about this proposal. Are the people commenting on the plan qualified to do so? Can students evaluate the qualifications of critics and supporters and the validity of their claims?

2. Divide the class into groups of four and distribute Handout 20-1. Allow a few minutes for students to read the simulation directions.

3. With the class as a whole, discuss the operation of the simulation. At this point, defer any questions that deal with values. Simply insure that students understand the mechanical aspects of the model and how they represent the actual system.

4 Stop the discussion and have students work in their groups to brainstorm lists of questions they have about the simulation. On the chalkboard, post these category headings: Values; Assumptions; Technology: Accuracy; Other. Groups should tag each of their questions to one of these categories—or some new category they perceive as important. Allow 10 minutes for the brainstorming.

5. Have each group pick the single most important question it has for each category. Each group should take a turn posting its questions on the board, insuring that no duplicates are posted. As questions are being posted, each student is to select one of the questions to answer for homework.

6. At the beginning of the next class period, collect the homework. Then have students discuss the questions they chose to answer. Help students analyze different answers to the same questions or different interpretations of similar answers. Remind students that the goal is to critically examine the simulation, not SDI itself. Ask students if they feel the simulation must actually be performed to make its point. What is the point of the simulation? How reasonable are the questions under the "Test Results" section? What other questions would they propose?

7. Conclude the exercise by having students complete these two statements:

- The simulation would be effective because...
- The simulation would not be effective because...

Evaluation:

The homework assignment and the responses to the statements in step 7 of the **Procedures** can be used for evaluation purposes.

Extension/Enrichment:

Have students find an argument presented by a supporter of SDI and subject it to the same type of analysis applied to the simulation in this lesson.

EARTH ISLAND'S "DO-IT-YOURSELF" SDI SURVIVAL TEST

Source: From *Earth Island Journal* (Summer 1987), p. 47. Text reprinted by permission of the Earth Island Institute Artwork reprinted by permission of Eclipse Comics. This comic strip was prepared as a public service by Eclipse Comics.

21. THE EFFECTS OF INDIVIDUAL ACTIONS ON TECHNOLOGY AND SOCIETY

Introduction:

Even in the largest, most complex projects, decisions made by individuals can have profound effects. While those effects are first felt within projects, they also have implications and impacts on entire societies. This lesson examines the decisions of two scientists who played central roles in the development of America's modern space and atomic sciences.

Objectives: Students will be able to:

1. Describe the work of Wernher Von Braun and Leo Szilard.

2. Use a decision tree.

3. Appreciate the responsibility scientists exercise in making decisions.

Subject/Grade Level: World history/grade 10; U.S. history/grade 11; government/grade 12; physics/grade 12

Time Required: 2 class periods

Materials and Preparation: Make an overhead transparency of the example decision tree, "Washington Attends the Convention." Make copies of Handout 21-1 for all students and enough copies of Handouts 21-2 and 21-3 for half the class.

Procedures:

1. Ask students if they think scientists ever have doubts about the projects they are working on. Let them speculate on the scientific advances or technological developments they think might have raised such doubts.

2. Next ask what a scientist might do if he/she had serious doubts about a project. How might they go about deciding what their response should be? After students have suggested some possibilities, tell them they will have a chance in this lesson to use a tool for making decisions to consider the dilemmas faced by two real-life scientists.

3. Distribute Handout 21-1 to all students. Project the "Washington Attends the Convention" transparency and allow time for students to examine it.

4. Explain to students that the decision tree is an analytical tool that helps students study the decisions of others as well as make their own decisions. It is based on a problem-solving procedure that involves mapping the likely alternatives and consequences of an occasion for decision. Decision trees graphically show the four key elements of decision making. As students fill in decision trees, they use these elements to analyze historical issues and decisions in a systematic fashion. These elements are:

Source: Adapted from *Turning the Tide: Technology Infusion Project* (Harrisburg, PA. Pennsylvania Department of Education, 1984) and *Lessons on the Constitution*, by John Patrick and Richard C. Remy (Boulder, CO: Social Science Education Consortium and Washington, DC: Project '87, 1986). Used by permission of the Pennsylvania Department of Education and the SSEC.

- *Confronting the need for choice—an occasion for decision.* An occasion for decision is a problem situation where the solution is not obvious. The occasion for decision is the *context* for the decision problem. For example, Washington, an advocate of a strong central government, was invited to attend the constitutional convention. To go to the convention involved serious political risks. Furthermore, Washington felt pressured to stay home to deal with serious personal problems. However, he wanted to be part of any moves to change the government of the United States.
- *Determining important values or goals affecting the decision.* One goal for Washington was to deal with his problems at home. Another goal, however, was to strengthen the government of the United States of America.
- *Identifying alternatives.* Alternatives in this situation were to attend the convention or to stay at home.
- *Predicting the positive and negative consequences of alternatives in terms of stated goals or values.* Washington considered likely consequences of his choices. For example, to attend the convention could lead him to neglect family problems. Missing the convention would forfeit his opportunity to help improve the government. However, staying at home would avoid any political risks, if the convention failed.

Point out to students that there is no one "correct" or "right" place to start on a decision tree. Sometimes students may start at the bottom with *alternatives* and work up. With other problems it may be more natural or appropriate to begin by considering the *values* or *goals* in a problem and work down. The students' perception of the goals involved in a decision or the alternatives available may change as they work their way through the decision tree.

5. To half of the class, distribute Handout 21-2; to the other half, give Handout 21-3. Have students read through their timelines. Note that on each reading an "Occasion for Decision" has been indicated with an asterick. Students may use the indicated occasion for decision as a basis for completing the decision tree or they may choose a different occasion for decision if they prefer. Allow the balance of the period for students to fill out the decision tree.

6. Have one student summarize Von Braun's life; then have a second student summarize Szilard's life. Have another volunteer explain the decision tree for Von Braun. Repeat for Szilard.

Evaluation:

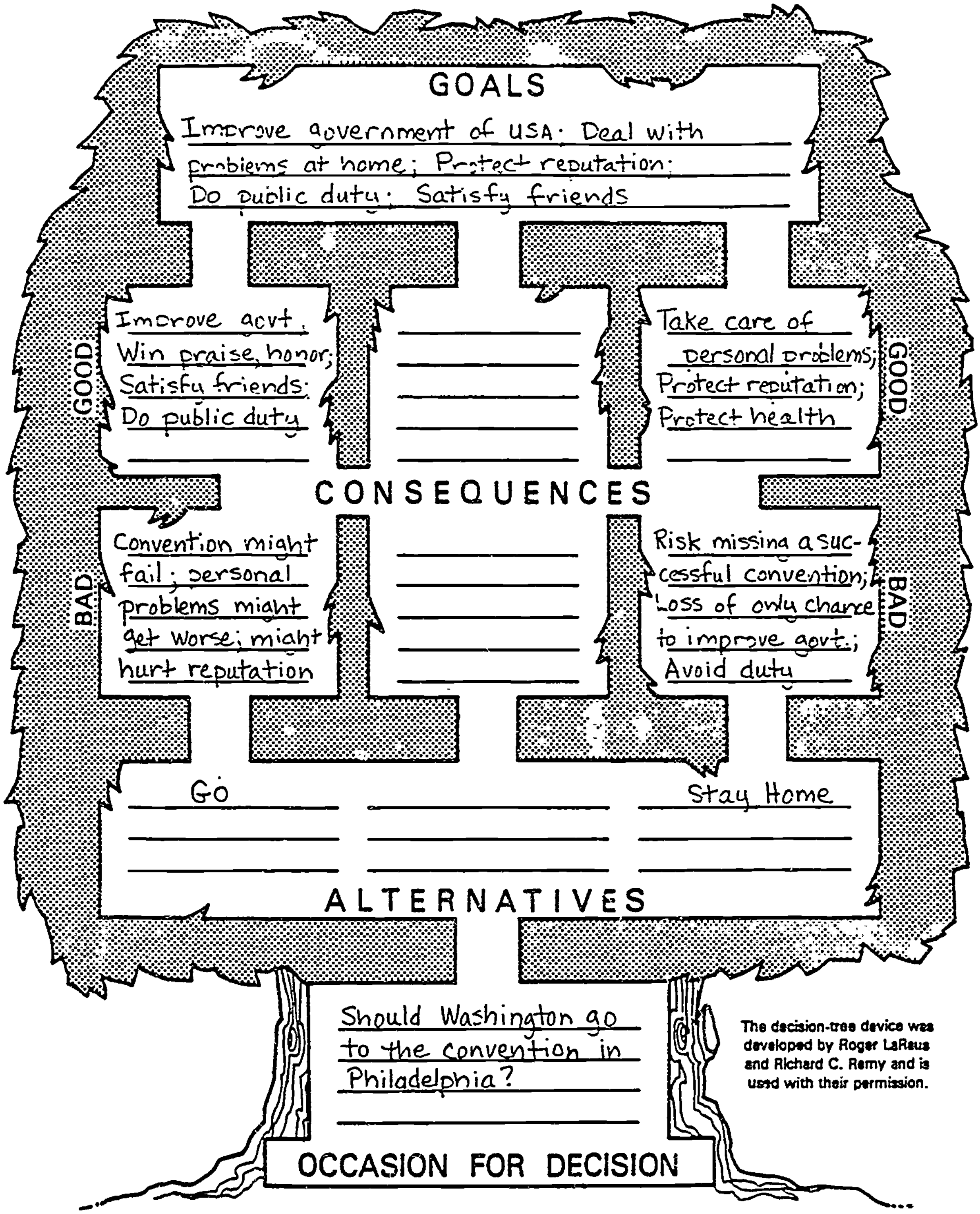
Have students compare the goals, values, and methods of the two men. Stimulate thinking using the following questions:

- What do students think about Szilard's call for secrecy? About Von Braun's alliance with the Nazis? What do their decisions show about their values?
- Which man made the "better" choices? How did students define "better"?
- What positive and negative consequences did each decision have?
- What scientific decisions (that we know of) are being discussed today that will affect our lives? (List these on the board.)
- What conclusions can we draw about scientific decisions and the people who make them?

Extension/Enrichment:

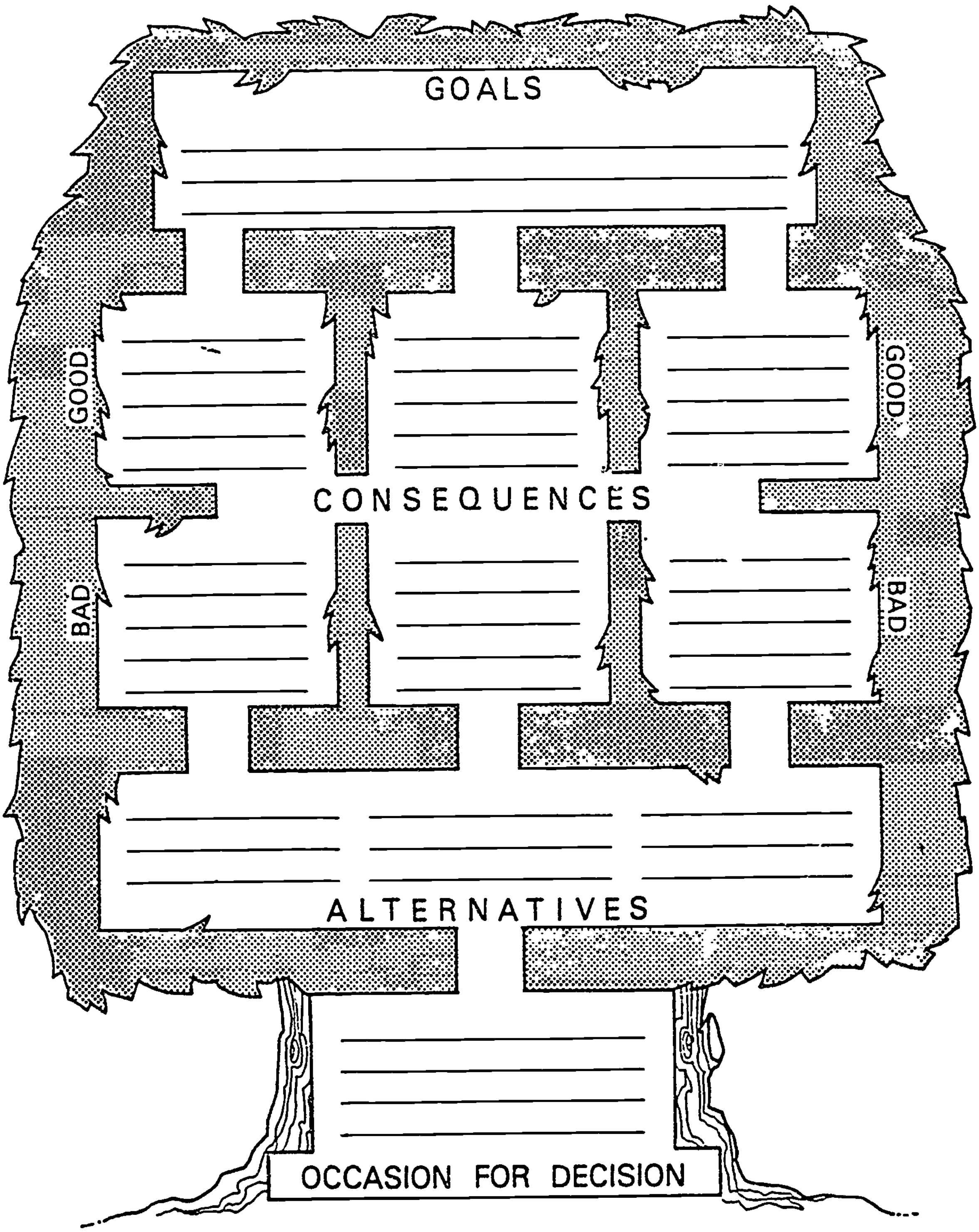
When using a decision tree, students learn that both facts and values are involved in decision making. Have students cut out newspaper or magazine articles about recent decisions relating to science. Have them list the factual questions that decision-makers identified in considering alternatives and their consequences. What values and value judgments were critical to the decision? Decision trees could be completed for the decisions students locate.

SAMPLE DECISION TREE



The decision-tree device was developed by Roger LaRaus and Richard C. Remy and is used with their permission.

DECISION TREE



The decision-tree device was developed by Roger LaRaus and Richard C. Remy and is used with their permission.

WERNER VON BRAUN—A WAY TO THE STARS

The following is a chronology of events related to V-2 development in Nazi Germany.

1912 — Von Braun is born on March 23.

1929 — German army begins active interest in rockets as weapons because of the Versailles treaty ban on long-range artillery.

1930 — Von Braun begins experimenting with liquid-fueled rockets.

1931 — At this time, as remembered by Von Braun, his father warned of the consequences if Hitler attained power.

1932 — Von Braun receives engineering degree. He fires small rockets for Army observers in September and October.

*He is hired as the first civilian employee by the Army and is placed in charge of rocket development. Von Braun said:

"...we were interested solely in exploring outer space...but we needed money."

1933 — Hitler takes control of the German government in January.

— Von Braun has reasonable success with small rockets.

— Many begin efforts to leave Germany; some succeed.

1934 — Von Braun receives doctoral degree

— In December, an A-2 (early V-2) reaches an altitude of 6,500 feet.

1936 — Hitler expresses interest in rockets as weapons.

— Pennemunde site, selected by Von Braun, is purchased in December.

1937 — Von Braun progresses to the A-3 (1,650 pounds, 21 feet long), which had guidance problems.

— Goals for the rocket weapon are established by comparison to the WWI Paris Gun:

Paris Gun — range – 80 miles, payload –23 pounds
A-4 (V-2) — range – 180 miles, payload –2,200 pounds (1,000 kilograms)

1938 — A revised A-3 is fired; it has a range of 11 miles.

1939 — Hitler observes firings in March and is not impressed.

— Poland falls in September.

— An advanced A-3 reaches an altitude of 7.5 miles.

1940 – France falls in June.

– Pennemunde cutbacks ordered as Hitler loses interest.

– Von Braun joins Nazi Party.

1942 – First A-4 fired in June (47 feet long, 13.5 tons total, 1 ton warhead).

– Third A-4 fired in October with impressive results; it reaches an altitude of 30 miles, breaks the sound barrier, and has a range of 118 miles. Films of this shot are used when Von Braun visits Hitler to obtain further support.

1943 – In July Hitler is impressed by films, models, etc.

– Von Braun is awarded an honorary degree for his work.

– Pennemunde is bombed by the RAF. Raids continue for next 13 months.

1944 – By early 1944, V-2's are being mass produced. They give poor test results. At Von Braun's insistence, special test models are prepared. He personally supervises tests, which pinpoint production problems, and test results improve. Mass production resumes.

– Von Braun is arrested by the Gestapo in March after refusing to aid Himmler in getting Pennemunde under SS control. He is released after a direct order from Hitler is secured.

– The first V-2 hits London in September.

1945 – Pennemunde is captured by the Russians in May.

– Von Braun arranges surrender to U.S. forces.

– Von Braun comes to the United States and is immediately a prime mover in the American space program. Von Braun's Nazi A-7 long-range missile design becomes the U.S. Redstone missile and is used for several early satellite launches.

– Von Braun is entered into the American Aviation Hall of Fame.

LEO SZILARD—SCIENTIST WITH A SECRET

The first three decades of the 20th century produced phenomenal growth in the field of physics. As the Nazi war machine prepared for its assault on Europe, a few physicists realized that a nuclear fission chain reaction was not only feasible, but also a source of incredible energy. One of those physicists, Leo Szilard, made every effort to prevent publication of experimental results from studies of nuclear fission., A chronology of events follows:

1933 – Szilard is among the first to recognize the possibility of a fission chain reaction.

1934 – Joliet and Curie (France) verify that artificial radioactivity is possible.

– Szilard (working in England) patents his work and gets the British government to declare his work secret.

1935 – Szilard attempts to start a "conspiracy of silence" in the general field of nuclear physics by requesting other physicists to restrict publication of experimental results. His idea is rejected.

1938 – Data verifying that neutrons cause uranium fission is obtained by a group of physicists in Germany as well as by physicists working in Denmark and Sweden.

1939 – Szilard approaches Fermi (both now working in the United States) about the need for secrecy. Fermi calls Szilard idea "Nuts"!

– Szilard approaches the French research group, requesting they hold back publication. They hesitate, but eventually publish their results.

– In March German troops invade Czechoslovakia.

– Shortly after the invasion, information from several sources is published, verifying all of the following: neutrons are produced by uranium fission; each fission produces two or three new neutrons; U_{235} is fissionable, but U_{238} is not. All these observations required very sophisticated techniques, and the work was only being done in the United States and France.

– Several German scientists describe possibilities of fission to the German government after publication of the above data.

– Soviet fission research is also begun.

– Awareness of the need for secrecy spreads in the United States.

*Einstein, urged on by Szilard, wrote to President Roosevelt to outline the state of nuclear research and to express alarm at the possible outcomes should Germany develop atomic weapons first.

1940 – Szilard withholds his own paper on nuclear reactors.

– Szilard convinces an American, Herbert Anderson, to withhold publication of a paper describing neutron absorption in uranium.

– Fermi and Anderson discover the feasibility of carbon as a neutron moderator.

– Szilard persuades Anderson and others to withhold publication of their data over Fermi's strong objections.

- German physicists were reaching the wrong conclusion about moderators and had decided that the rare isotope, deuterium (heavy water), was necessary. They were never able to obtain enough to test their ideas – if they knew that the readily available carbon (as graphite) would work, they might possibly have had sufficient data to produce both nuclear reactors and nuclear weapons.

- Szilard stops publication of a paper describing plutonium production.

- Finally, Szilard gets enough support to have the National Academy of Scientists impose censorship.

1942 – The Manhattan Project is set up to research nuclear reactions and determine the feasibility of atomic weapons.

1945 – Szilard, along with six other scientists of the University of Chicago Committee of Social and Political Implications, signs a petition protesting the expected use of atomic weapons on Japan. The group proposed a non-lethal demonstration before United Nations representatives as one way to convince Japan to surrender.

- Szilard gives up physics and enters the field of biological research.

22. GIVING UP THE GUN

Introduction:

The Japanese are known for intense devotion to their values. Through the course of history, those values have changed as the times have changed. Notable among those changes was Japan's decision to eliminate guns from its arsenal in the 17th century. This lesson examines that process of stepping back and explores possible reasons for that decision. The lesson is most effectively used after students have acquired some knowledge of Japanese history, culture, and geography.

Objectives: Students will be able to:

1. Make persuasive presentations.
2. Explore traditional Japanese values.
3. Discuss the role of values in influencing choices in science and technology.

Subject/Grade Level: World history/grade 10

Time Required: 2-3 class periods

Materials and Preparation: Make copies of Handouts 22-1 and 22-2 for all students. Make one set of the role cards. Provide poster paper and crayons for visual aids. You may also wish to become familiar with the content background before beginning the lesson.

Procedures:

1. Write this statement on the board: "Alas! Can we ring the bells backward? Can we unlearn the arts that pretend to civilize and then burn the world? There is a march of science; but who shall beat the drums for its retreat?" (Charles Lamb). Have students read and discuss the quotation. Following the discussion, poll students to determine how they would answer Lamb. Tell the students they will be examining one retreat from technology in this lesson.

2. Distribute Handout 22-1 and allow time for students to read it. Divide the class into five groups and give each group one role card. Have students begin planning. Encourage students to develop charts, drawings, or other aids to help support their positions.

3. At the beginning of the next class period, reconvene the groups and allow ten minutes for final preparations.

4. Distribute Handout 22-2 to each student. Begin the presentations, allowing five minutes for each group. The teacher or a student may act as the Shogun. Remind students to address the Shogun with dignity and respect. Audience members are to summarize each group's arguments on Handout 22-2.

5. Following the presentations, the Shogun should announce the decision (provided in the **Teacher Background Information**) and outline how it will be carried out. Students are to summarize the announcement on Handout 22-2.

6. Discuss the strong and weak points of each argument. Which was most persuasive? Least persuasive? Why? Which of the arguments (if any) were economic? Social? Physical? Philosophic? Most of the arguments are quite abstract rather than practical and concrete. How might that have affected their impact on the Shogun? How would these arguments work in a culture other than Japan? What would the results have been if the farmers, rather than the samurai, presented their own arguments against guns?

Evaluation:

Have students complete these statements:

1. In the 17th century Japan was able to abandon firearms because...

2. A similar ban on guns is/is not possible in most nations today because...

Extension/Enrichment:

Students may want to research more completely the samurai ethos. They might also compare the 17th-century decision to Japanese disarmament after World War II. Are there any similarities in the two cases? Why or why not?

Resources:

Beer, Lawrence Ward, ed., *Constitutionalism in Asia: Asian Views of the American Influence* (Berkeley, CA: University of California Press, 1979).

Itoh, Hiroshi, and Lawrence Ward Beer, *The Constitutional Case Law of Japan: Selected Supreme Court Decisions, 1961-70* (Seattle, WA: University of Washington Press, 1978).

Perrin, Noel, *Giving Up the Gun: Japan's Reversion to the Sword, 1543-1879* (Boulder, CO: Shambhala, 1980).

Teacher Background Information:

The following material can be read aloud when it is time for the Shogun to announce a decision.

The Shogun's Decision*

I have long considered the announcement I am about to make. Your humble pleadings have been heard. Firearms have proven to be an especially evil force in Japan. Introduced by the West, it is necessary for us to reassert our humanity and stop the further spread of this foreign poison. The following steps will be initiated immediately.

First: We will summon the leading gunsmiths from across the nation here to Edo. I personally shall present them with swords and promote them to the rank of samurai. Thus, they will owe personal allegiance to me.

Second: The manufacture of guns and gunpowder will be restricted to the city of Nagahama. All gunmakers must move there.

Third: All gunsmiths living in Nagahama will be provided with a guaranteed annual income, regardless of the number of guns they produce.

Fourth: All orders for guns must be approved by the Commissioner of Guns here in Edo. The guidelines for approval will be very strict. The central government has priority in filling orders. I expect to order mainly large cannon and few muskets.

Fifth: Christianity is hereinafter outlawed. European businessmen will be confined to the island of Deshima, Nagasaki. Only one Dutch ship per year may land there.

*Adapted from *Giving Up the Gun*, Chapter Five, by Noel Perrin (Boston, MA: David R. Godine, Publisher, 1979). Copyright 1979 by Noel Perrin. Reprinted by permission of David R. Godine, Publisher.

Let history show that this plan should result in the following events:

- Gunmaking will be centralized and thus easily controlled by the government.
- Gunsmiths will be unhappy with their small salaries, so they will soon return to making swords.
- The small orders from the government will taper off even more. By the next century I project that orders will total only about three dozen large matchlocks each even-numbered year and a couple of hundred small ones each odd-numbered year.
- Under the Shogunate system I have so recently established, there will be few major battles. By about 1640 I expect the entire nation to be firmly under my control. All foreign influences will be expelled!

GIVING UP THE GUN

This is a true story of an almost unknown incident in history. A civilized country voluntarily chose to give up an "advanced" military weapon and to return to a more "primitive" one. It chose to do this, and it succeeded.

Feudal Japan independently developed governmental system similar to that of feudal Europe. Between the eighth and sixteenth centuries, wealthy Japanese knights, the samurai, practiced a code of chivalry called Bushido. The samurai worked in close cooperation with the complex religious culture, just as the knights did in Europe.

Portuguese traders brought the first firearms to Japan in 1543. By 1575 Japanese warlords were able to field armies with thousands of matchlock weapons.

Yet in 1855, when the USS Vincennes anchored at Tanegashima Island, Commander John Rodgers found the islanders almost completely ignorant of ordinary 19th-century weapons. In the 16th century the islanders had been the first Japanese to use and manufacture guns. What had happened in the years from 1575 to 1855? The answer is that a decision was made by the leader of Japan, the Shogun Ieyasu Tokugawa. He decided to put a plan in place that would eliminate the use of guns in Japan. But why...? That is the question you will explore in this assignment.

Assignment

Five groups of samurai have developed separate reasons for asking the Shogun to end the use of firearms in Japan. Each group will present its reasoning to the Shogun and ask him to ban firearms. Work with your assigned group to present a convincing plea based on the reason you will be assigned. Use whatever historical evidence you can discover to develop your case. Start your presentation with a simple, clear statement of your position. Close your presentation with the same statement.

POSITION CHART

	Summary of Main Points	How Effective?			
		Very	Some	Little	Not At All
Group 1					
Group 2					
Group 3					
Group 4					
Group 5					

ROLE CARDS

Group One

Guns have made it possible for even the crudest farmer to be trained to kill. While guns provide a fast and effective way to raise a deadly army, farmers possess neither dignity nor sufficient learning and humanity to use them properly. If common folk are allowed to be warriors, our position as the elite of the nation is in jeopardy.

Group Two

Since islands are inherently difficult to invade and the Japanese are such formidable fighters, traditional weapons are sufficient to maintain the geopolitical integrity of the nation.

Group Three

Foreign ideas and foreign materials must be expelled from the nation. Christianity and Western business practices must be made illegal. Foreign imperialists must be ejected from the nation so that our purity may be preserved.

Group Four

For traditional philosophic reasons, swords have a much deeper symbolic value for Japanese than they do for Europeans. Swords are major works of art and thus are symbols of honor and social standing. Swords are metaphors for human characteristics. Replacing swords with guns would be too great a price for us to pay, simply to achieve greater killing efficiency.

Group Five

There are aesthetic reasons for eliminating guns. Swords require elegant, graceful movement. Samurai are trained in the precise rules of body movement for persons of quality breeding. The body positions for firing guns violate all of the rules of elegant movement just to achieve ugly killing efficiency. Major warfare may have justified the indignities of ungainly posture, but in peacetime one should revert to good taste.

23. RENEWABLE ENERGY AND THE AMERICAN AGE OF WOOD

Introduction:

Renewable energy resources played a larger role in the development of industrial America than historians have generally acknowledged. Consequently, the uses of such energy sources as water power, wind power, and wood fuel have been relegated in most textbooks and classrooms to the quaint and superfluous. This lesson attempts to correct such omissions by focusing on the role played by water power and wood as fuel during the 1840s and 1850s.

The lesson focuses on a decision faced by numerous 19th-century business enterprises: whether to use steam-powered engines. Students representing different types of business activity must decide whether to utilize steam-powered engines or some alternative source of power.

Objectives: Students should be able to:

1. Evaluate data as to their usefulness in weighing alternatives of stationary steam and water power.

2. Use data to support arguments defending a decision whether to utilize steam or water power.

3. Identify factors that influenced the use of energy in the 1840s and 1850s.

4. Identify the advantages and disadvantages of various forms of energy available in the 1850s.

5. Weigh alternative energy uses in the 1850s and the contemporary world.

6. Appreciate the importance of data in making decisions about science-related issues.

Subject/Grade Level: U.S. history/grade 11; economics/grade 12

Time Required: 4 class periods

Materials and Preparation: Make copies of Handout 23-1 for all students. If you choose to have students read the material on "Wood and Water as Energy" rather than lecturing on it yourself, make copies of Handout 23-2 for all students. Prepare one set of Situation Cards and 10-15 copies of the Data Packet; you may wish to cut the items in the Data Packet apart and place each packet in a manila envelope. You will also need five overhead transparencies and markers.

Procedures:

1. Divide the class into five groups. Distribute Handout 23-1 to each student and review instructions with the class. Distribute a different Situation Card to each group. Also give each group two or three copies of the Data Packet.

2. Present the "Wood and Water as Energy" material, either through a lecture or student reading and class discussion of Handout 23-2.

3. Reassemble the groups and have them begin work on the written reports. Allow a full class period to complete the papers.

Source: Adapted from "Teaching About the Uses of Renewable Energy Sources During the Age of Wood," by Clair W. Keller, Professor of History, Iowa State University. Reprinted by permission of the author.

4. Allow another full class period for students to work within their groups to determine the best power source for their customer. By the end of the period, they should have outlined their supporting points on the overhead transparency.

5. Have each group present its situation, recommendations, and reasoning to the class. Post the following questions on the board and have each group respond to them following their presentation.

- What factor was the most persuasive in making your decision?
- What additional information would have been helpful?
- How valid was your group's decision?

The best solution for Situations A and C would be steam power. The Savannah Sawmill (C) is an actual mill. The Philadelphia Ironworks (A) would use steam simply because steam was an urban development. It would also employ coal as fuel. Situation B is also a real mill run by water power. It is described in John Borden Armstrong, *Factory Under the Elms: A History of Harrisville, 1774-1869* (Cambridge, MA: MIT Press, 1969), pp. 21-28. Situations D and E are representative of the small mills that continued to employ water power well into the late 19th century.

6. Conclude the lesson by discussing the following questions with the class:

- What factors determined the use of energy in America in the 19th century?
- Is it valid to equate steam power with industrialization? Discuss the validity of this statement: "The industrial revolution was based on the application of steam (with coal as the source of power) to the textile, milling, and lumber industries."
- What type of energy choices do manufacturers have today?
- What factors must contemporary industries consider when making energy choices?

Evaluation:

Have each student write a paragraph analyzing the strengths and weaknesses of his/her group's decision.

Extension/Enrichment:

Students may wish to pursue the topic of changes in energy use over time through research papers. Local community-based studies would be especially interesting. Differential billing rates for electrical power, fuel sources for local utilities, and the transformation of wastes into fuel could be topics for research.

Resources:

Clair W. Keller, *Involving Students in the New Social Studies* (Boston: Little Brown, 1974), pp.41-56.

John Borden Armstrong, *Factory Under the Elms: A History of Harrisville, 1774-1869* (Cambridge, MA: MIT Press, 1969).

Carroll M. Pursell, Jr., *Early Stationary Steam Engines in America* (Washington, DC. Smithsonian Institution Press, 1969).

ASSIGNMENT SHEET

1. Your group is to represent an energy consulting firm. You make recommendations to business owners about the kind of energy they should use.

2. Each member of your consulting group is to review the material on "Wood and Water as Energy" and the Data Packet. Each member is to write a discussion paper that explores the advantages and disadvantages of using steam or water power in the situation described in your Situation Card. As a conclusion, each member is to decide which would be the most advantageous power source for the business you are advising. Defend the decision with specific facts from the Data Packet.

Due ________________________

3. Meet as a group and decide which power source you will recommend to the business owner. Outline your reasons on an overhead transparency as the basis for a presentation to the class.

As you prepare your papers and your presentations, consider the following aspects of the problem:

a. Costs: initial investment, operation and maintenance, labor, buildings

b. Hazards: fire, flooding, droughts

c. Environment: cleanliness, pollution

d. Transportation needs

WOOD AND WATER AS ENERGY

Wood

Brooke Hindle writes in the introduction to a collection of essays entitled *America's Wooden Age*, "In this country, a technology broadly based upon wood and a society pervasively conditioned by wood persisted until the mid-19th century when wood began, selectively, to be replaced by a rising utilization of other substances."[1]

Wood was the major source of fuel, the primary building material, and a major source of chemical inputs such as potash and charcoal. As a result, the per capita consumption of wood in America increased during the first 70 years of the 19th century. America's consumption of wood was three and one-half times that of Great Britain.[2]

The availability of land was undoubtedly the strongest magnet attracting colonists to the North American shores. Closely related to the land, however, was the abundance of wood. Wood, like land, had become a scarce item in England and Europe. In 1623-1624, John Winthrop, who led the Puritan migration to Massachusetts, wrote that the scarcity of wood had driven the poor to continually chop down not only young trees and hedges but gates and bridges as well.[3]

The importance of hogs in the colonial diet resulted from the abundance of forest. Hogs could survive in the forests; sheep and cattle could not. This also meant that crop lands had to be fenced. The need to keep fences in good repair and disputes over violations led to numerous regulations, as well as the town office of fence viewer.

It should be pointed out, however, that tradition did not always give way to the forest. New England settlers continued to construct traditional English frame houses even though log cabins would have been ideal dwellings. Log cabins could have been built with the axe alone, without nails or other hardware!

Wood as a fuel for heating homes certainly influenced the growth of colonial America in many positive ways. The abundance of wood, for example, enabled colonists to live more comfortably than their counterparts in Europe. The colonists wasted a great deal of their space-heating energy by using inefficient fireplaces. When wood became increasingly expensive in urban areas because of transportation costs, the Franklin stove was developed to save fuel. Comfortably heated colonial houses contributed to the enormous population increase during the 18th century by decreasing the death rate among the colonists.

Wood as a fuel survived long after the arrival of the steam engine. The cheap and ready supply of wood along America's numerous waterways was a primary factor in the success and rapid expansion of the steamboat. A free and easily supplied source of fuel cut the cost of operating the steamboat and enabled it to become immediately competitive with other forms of transportation.

The availability of wood also influenced the spread of early railroads. Railroads ran on wooden rails and ties and spanned rivers and gulleys over wooden truss bridges. Locomotives were first made of wood rather than metal.

Wood was also a cheap fuel for railroads. When Americans imported English locomotives, they converted them from coal to wood. American-built locomotives were wood-burners. Wood served as the principal fuel used by locomotives during the 1830s and 1840s. Even naval vessels continued to use wood, rejecting a commission recommendation in 1844 urging naval vessels to shift to coal. Before coal-burning engines could become economically competitive, the inefficient methods being used to take care of coal residue had to be improved. These changes didn't come about until the mid-1850s.[4] Even then, wood-burning engines still dominated in New England and the South, where wood supplies were abundant, and in the west, where coal was scarce.[5]

Water Power

American Industry before the 1840s rested overwhelmingly upon water power. Even in 1870, according to the census of that year, 48 percent of the stationary power was provided by water power.[6] Historian Louis Hunter even questioned identifying British industrialization with steam power.

There were several reasons for the limited use of steam power in the first half of the 19th century: (1) its high initial cost; (2) unfamiliarity with its operation, maintenance, and repairs; (3) high operation costs; (4) difficulty and cost of transporting heavy equipment, such as engines and boilers; (5) the widespread, familiar low-cost alternative—water power; and (6) the steamboat boiler controversy raising the issue of boiler safety.[7] One might add also that the cleanliness, smaller space requirements, and safety of water power encouraged its use.

The importance of water power was of long standing. Like the early Americans who saw the abundant forests, the first Europeans in America also marveled at the numerous rushing rivers and streams. An abundant water power supply eased the task of providing food, shelter, and clothing and certainly contributed to the high standard of living shared by most white colonists.

The first water wheels provided power for sawmills because there were abundant supplies of wood available long before large quantities of grain were available. The first sawmill was built on the James River in 1611. The Virginia Company recruited German technicians from Hamburg to build a sawmill at the falls, thus making it possible to construct the new town of Henrico, which had three streets of well-framed houses.[8]

It is not surprising that sawmill technology, much of it imported from Europe, improved rapidly as the colonists sought to maximize the abundant resources of water and forest. Sawmills in colonial America antedated their introduction in England. Every new community established a sawmill as its first priority. The location of the sawmill often dictated the town's location.

Although water power dominated the industry, steam was utilized for sawmills as early as 1802. In that year in Philadelphia, an owner advertised that mill refuse could be used for fuel and wood ashes were excellent for fertilizer. The familiar hazards of water power—drought and flood—would be eliminated, the advertisement said. A coal-burning, steam-powered saw was reported in New York a few weeks later. Despite the claim that the sawmill would "soon make a fortune for the owner," most sawmills continued to be water-powered. In 1860, for instance, only 174 of Ohio's 437 sawmills were powered by steam.[9]

Soon after erecting a sawmill, the colonists built a gristmill, often at the same site. Although horizontal mills, which needed no gearing, had been used by the Greeks as early as 85 B.C., not all colonists could afford to build them. Many ground grain by hand. Early colonists sometimes used a simple devise called a plumping mill. This inexpensive and easily built water-powered gristmill operated like a teeter-totter with a wooden box that filled with water on one end and a pestle at the other end. "When the box was full, the weight forced the sweep downwards. The box then emptied on descent, thereby releasing the weight as it swung back again to the filling position. The counter weight, shaped like a pestle, dropped into a hardwood mortar in which the grain was placed, thus pounding the grain into a course flour."[10] Thus water power replaced the laborious task of pounding the grain by hand.

When communities built horizontal mills, they were often simple "tub wheel" mills designed to serve small communities or individual families. A stream of water was directed to a horizontal wheel, 4 of 5 feet in diameter, located beneath the mill. This turned a shaft connected to a mill stone attached directly above.[11] These horizontal mills were later replaced with the more efficient vertical water wheels, which operated by directing water to either the top (the most efficient method), middle, or bottom of the wheel. Using the vertical wheel required gearing to change direction of the power, something accomplished by the Romans. Gearing also enabled the millstone to turn at greater speed than the water wheel.

Some water wheels were powered by the tide, filling a mill pond at high tide, then directing water to a wheel during low tide. They would operate for about 5 1/2 hours during each 24 hours.[12]

Some water-powered gristmills operate today, not because they are economically sound (although this may soon be the case) but because the meal, which absorbs the dampness of the mill site and has been ground finely on slow-turning old stones, produces exceptional bread.

Summary

The Americans relied on wood and water as sources of energy well into the last half of the 19th century. These energy sources were well suited to a predominantly rural and agricultural society. The steam engine powered by coal, diesel, or gasoline is a phenomenon of the city, where forests and bubbling brooks seldom exist. The high energy costs at today's market place may make wood and water power more than just a nostalgic harkening toward the past.

Footnotes

1. Brook Hindle, "The Span of the Wooden Age," in Brook Hindle, ed., *America's Wooden Age* (Tarrytown, NY: Sleepy Hollow Restorations, 1975), p. 3.

2. Charles Carroll, "The Forest Society of New England," in Hindle, *op. cit.*, p. 5.

3. *Energy, Engines, and Industrial Revolution* (Washington, DC: U.S. Department of Energy, August 1979), pp. 43-44, 51.

4. Edward Keuchel, "Coal Burning Locomotives: A Technological Development of the 1850's," *Pennsylvania Magazine of History and Biography*, Volume 94 (October 1970), p. 486.

5. *Ibid.*, p. 485.

6. Louis Hunter, "Waterpower in the Century of the Steam Engine," in Hindle, *op. cit.*, p. 170.

7. *Ibid.*, pp. 172-173.

8. Charles Peterson, "Early Lumbering: A Pictoral Essay," in Hindle, *op. cit.*, p. 66.

9. *Ibid.*, p. 76.

10. Charles Howell, "Colonial Waterwheels in the Wooden Age," in Hindle, *op. cit.*, p. 121.

11. *Ibid.*, pp. 24-30; Hunter, *Waterpower in the Century of the Steam Engine* (Charlottesville, VA: University of Virginia Press, 1980), pp. 71-81.

12. Eric Sloan, *Our Vanishing Landscape* (New York: Ballantine Books, 1974), p. 38.

SITUATION CARDS

Situation 1

You are consultants for the owner of an ironworks who needs a power source for a stamping plant. The plant will be located in Philadelphia with access to water and rail transportation. While the facility is not large, it will employ 15 workers. The owner hopes to expand the plant.

Situation 2

You are consultants for an owner who wants to build a woolen mill in Harrisville, New Hampshire. It will be located near a stream that can be dammed for a millpond. The stream, although small, has potential for further dams and millponds. The factory will consist of three floors.

The owner will install three sets of machinery for manufacturing woolen cloth such as broad cloth, cassimeres, and black doeskin and has hopes of further expansion. The plant will employ 15 men and 10 women. There is no railroad, although there is talk of getting one sometime in the future. The owner will invest $18,000 in a plant that will have 600 spindles and produce 40,000 yards of cloth annually.

Situation 3

You are consultants for a Southern sawmill owner who wants to build a sawmill along the Savannah River near Savannah, Georgia. The plant will employ about 50 persons and will require about $70,000 of capital investment. The plant will have three vertical saws, four circular saws, and two planning machines and will produce shingles, laths, and lumber.

Situation 4

You are consultants for an owner who wants to construct a gristmill to serve local farmers in an agricultural area in Pennsylvania. The mill will employ around 5 persons.

Situation 5

You are consultants for an owner who wants to build a sawmill in Ohio. The area is being settled rapidly. While the planned facility will be small, employing fewer than 5 persons, the owner hopes to expand the plant.

DATA PACKET

Item 1

"The motives which have led to the establishment of works at small towns, eight and ten miles from the great points of shipment referred to, have been the lower price of land and the cheaper rate at which employees can live. We think it has been the experience of most manufacturers that more work has been lost by thus isolating themselves than would have many times over paid the interest on increased value of land." (Charles Wilcox, "IronWorks—Their Location, Arrangement and Construction," *Scientific American*, 15 September 1860, pp. 180-181)

Item 2

"Steampower costs proportionately very much more in small than in large quantities. Independent of this, however, small engines and boilers are much less economical than larger ones, so that the cost of fuel is much larger even at a fixed price per ton." (Charles Emery, "Cost of Steampower," *Transactions—American Society of Civil Engineers*, 1883, p. 430)

Item 3

"The waterfall is rendered available comparatively without labor, and furnishes its supplies without the intervention of human aid. The energies of the steam engine, on the contrary, can be commanded in any situation, only by the influence of the miner; and the localities much removed from sources of fuel, can only be sustained at an expense which falls heavily upon the operations to which they are subservient. That expense, it is true, is continually being diminished, and by means of the steam engine itself, in its character as a carrier; but no happy discovery, no possibility, can reduce it to the minimum at which our water-runs are maintained." (Appleton's *Dictionary of Machines*, 1852)

Item 4

"For many users waterpower was preferred for its cleanliness and the small space requirements of the equipment, and for freedom from the fire and explosion hazards of steampower, from the dirt and nuisance attending the handling and storage of fuel and ashes, and from the burden and expense of engine—and boiler room attendance." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 519)

Item 5

"Waterpower unit costs tended to increase with the size of the plant. Reverse was nearly always the case for steampower." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 519)

Item 6

"New engines developed after 1850 reduced fuel consumption from 10.0 to 2.5 pounds of coal per horsepower hour. Initial costs of steamplants were down, in part owing to the lower expense of transportation from engine builders. Maintenance and repair costs also decreased." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 487)

Item 7

"In 1854 James B. Francis, Superintendent of Lowell Industries, reported that steampower costs were three times those of water power for Lowell plants. Ten years later he reported the ratio had fallen to two to one, changing only slowly during the succeeding years. Francis declared that 'the highest rates of water power I know of are about half the cost of steam power, say $70 per horsepower per annum'." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 521)

Item 8

"In 1858 Frances wrote that the cost of water power at Lowell ranged from $15-$25 per horsepower per year, with steam power costs for coal alone in 1863 being $27.90." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 521)

Item 9

"After the Civil War—motive power was but one among many locational factors to be weighed and more commonly than not a minor one—5-10 percent of total production costs. By this time such cost advantages water power still possessed over steam power might readily be overruled by other cost and advantage considerations." (Louis C. Hunter, *Waterpower in the Century of the Steam Engine*, 1980, p. 484)

Item 10

"For a country sawmill operated by men having other duties at times, a simple torrent, dry or nearly so at times during the summer, will answer very well. The farmers' boys can get in their harvest in the dry season, get out and haul logs before the snow melts, and saw them by water power when the stream is full. Everything is of the simplest description; no labor is left idle, and the cost of the whole plant is so small that the mill may be unused for long periods without a loss worthy of consideration.

Such a state of things is not possible with the manufacturing interests of modern times. Large contracts are to be filled; large numbers of operatives are employed, skilled only in particular branches of the particular work done; hundreds of thousands of dollars of capital are invested—the mills cannot be stopped if the owners hope to compete with others doing business in a business way. If the water power fails for a season, steam is employed; and indeed, from its greater reliability, steam is used exclusively in many cases successful competition with water powers." (Charles E. Emery, "The Cost of Steam," *Transactions—American Society of Civil Engineers*, 1883, pp. 429-430)

Item 11

A letter from a farmer described the use of small steam engines as follows: "Three hp engine can be drawn by a single horse, 5 hp engine can be drawn by two horses, 8 hp can be used for sawing, pumping, and turn small mill stones. A 5 hp engine consumes about 1/4 cord of wood per day. Wood varies from $2.50-$3.50 per day when purchased." (*Scientific American*, 18 February 1854, p. 184)

Item 12

"Cost of Constructing a Cotton Mill with 4000 spindles. Waterpower Wheel, $1300, Steam Engine, $6000, gearing and belting, $3000; 60 hp needed to turn 4000 spindles. Building 40 x 130 feet and 3 stories high cost $12,000, employed 132 workers." (*Scientific American*, 4 August 1848, p. 365)

Item 13

Letter reports that a 38 hp engine ran 292 days, 10 hours per day, and consumed $5.77 of coal per day or $.15 per hp per day. It had two boilers 30" x 30". It took 8-1/8 pounds of coal to grind one bushel of wheat into flour. Wheat costs around $1.75 per bushel. (*Scientific American*, 17 April 1858, p. 251)

Item 14

Advertisement: "Circular Saw Mill with Engine and Boiler purchased in New York, cost $1500." (*Scientific American*, 30 August 1856, p. 407)

Item 15

Advertisement: "2-1/2 hp engine cost $240, weighs 500 lbs. and is 5 by 3 feet. Boiler is extra." (*Scientific American*, 30 August 1856, p. 407)

Item 16

By 1850 coal and wood were competitive when burned by locomotives. (Keucher' "Coal Burning Locomotives: A Technological Development o. the 1850's," *Pennsylvania Magazine . History and Biography*, October 1970, p. 486)

Item 17

Letter: "We have put into a grist mill which runs 3 pairs of stones (4 feet diameter) a 25 hp engine with a 20' by 48". It burned 1 bu. coal to grind 10 bu. of wheat or rye. Some engines consume 50 bu. coal to grind 200 bu. of grain." (*Scientific American*, 1858, p. 208)

Item 18

Advertisements for cost of Engines and Boilers:

"1 hp, $275; 3 hp, $450; 6 hp, $600; 8 hp, boiler was 16' by 30"; 30 hp without boiler, $1037; 10 hp, $1000." (*Scientific American*, 12 July 1856, p. 351)

Item 19

Cost of Operating Steam Engines

	5 hp	25 hp	100 hp
Cost, Eng./Boiler	$500	$2000	$9000
Operating/hp/year without coal	$131	$ 37	$ 17
Cost of Coal at $4.17 per ton/hp/year	$ 43	$ 30	$ 19

(Adapted from table in Charles Emery, "Cost of Steampower," *Transactions—American Society of Civil Engineers*, 1883, p. 430)

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24. ENERGY MILESTONES

Introduction:

The wheels of history have been turned by energy. New nations have grown on energy. Wars have been fought over energy and decided by energy. Today's world depends on energy. The history of energy use in America is a fascinating story for students to explore. This lesson starts them on that exploration.

Objectives: Students will be able to:

1. List significant events in the history of energy use in the United States.

2. Present information on a timeline.

3. Appreciate the role of energy in our past, present, and future.

Subject/Grade Level: U.S. history/grade 8; economics/grade 12; physical science/grades 8-9; general science/grade 9; environmental studies/grades 9-10

Time Required: 1-2 class periods

Materials and Preparation: Cut butcher paper into enough one-meter lengths for one sample timeline you can prepare in advance and one blank length for each student. Make copies of Handout 24-1 for all students. Gather such source materials as history texts, dictionaries, and encyclopedias. Students will also need meter sticks and crayons or markers.

Procedures:

1. Distribute Handout 24-1. Have students read through it. Then have students go back through the timeline and mark a star next to the 12 energy milestones they think are the most interesting or important.

2. Tape your model timeline on the board. Distribute the poster paper, crayons, and meter sticks. Have students mark 1600 at the bottom of the lengthwise sheet. At 250 cm, mark 1700; at 500 cm, 1800; at 750 cm, 1900; at the top, 2000. Divide each section into quarters: 1625, 1650, 1675, and so on. At the top, write the title: "An Energy History Timeline."

3. Have students copy their 12 starred milestones onto the timeline with the crayons. Be sure that each one is properly located next to its date.

4. Using the dictionary, the encyclopedia, and history books, have students try to find pictures that go with their 12 milestones. For example, they might find a picture of Cyrus McCormick's reaper to go with the milestone about how the reaper changed farming in the 1840s and 50s. Students may copy the pictures or devise their own to draw on the timelines.

5. Allow a few minutes at the beginning of the next class period for students to complete their research and drawings. Then allow time for students to circulate and examine each other's work.

6. Bring the class to order and discuss their findings. Typical questions to ask include:

- Why did you pick the events you did? How/why were they important?

Source: Adapted from "Energy Milestones," from the *Fossil Fuels* activity booklet (Albany, NY. Energy Education Project, 1985). Used by permission of the publisher.

- What changes did you see over the course of time?
- How did the types of fuel change? List the fuels.
- What were the advantages and disadvantages of each fuel?
- What were the changes in the technologies that used those fuels?
- What were the changes in the transportation methods?
- How has energy changed over time?
- What inventions helped develop or discover new energy sources?
- What inventions increased energy usage?
- What inventions decreased energy usage?

Evaluation:

Have students complete this thought by writing a five-sentence paragraph: "Based on the history of energy in America, we can predict that in the future..."

Extension/Enrichment:

Have each student pick one of the energy milestones and research three other events occurring in the same era in U.S. history. Were these events related to the energy milestone in any way? If so, how?

ENERGY MILESTONES

Pre-1620	Early Native Americans depended on their own muscle power. They used wood fuel for heating, cooking, baking pottery, and working metal.
1620	Settlers began to come to America from Europe in wind-powered sailing ships.
1600s and 1700s	Settlers, black slaves, and servants used muscle power for farming, building, and many crafts.
1600s and 1700s	Settlers used horses and oxen for farm work and transportation.
1700s	Water-driven mills were used to grind grain, saw lumber, and run machinery.
1770s	England cut off America's coal supplied during the Revolution. The colonies started mining their own coal, which they needed for casting cannon.
1782	James Watt invented a steam engine that would run machinery, powered by burning wood or coal.
1790s	Wood-burning stoves began to replace fireplaces for cooking and heating.
1800	New inventions for making thread and cloth appeared: the spinning jenny, the power loom, and the cotton gin. These were run first by muscle power, then water power, and finally by steam engines.
1807	Robert Fulton's steamboat, the *Clermont*, went from New York to Albany. The age of steam transportation had begun.
1816	Gas from coal was first used for lighting.
1821	The first natural gas well in the United States was drilled near Fredonia, New York.
1825	The Erie Canal was dug to provide low-energy transportation to the West.
1829	The first electric generators were invented.
1830s and 40s	Cyrus McCormick's horse-drawn mechanical reaper changed farming. With the reaper, one person could do the work of five.
1850s	The Erie and New York Central Railroads were formed. They competed with the canals to transport passengers and goods.
1850s	Steelmaking was introduced in the United States, creating a new need for coal.
1856	William Henry Perkin discovered how to make coal tar dyes. This began the synthetics industry.
1859	The first successful oil well was drilled in Pennsylvania by Edwin Drake. At first, oil was used mostly to make kerosene for lamps.
1860s	A lack of coal hurt the southern states during the Civil War.
1860s and 70s	New ways of drilling for and refining oil were discovered.

1870s	The first successful gasoline-burning automobiles were invented.
1870s	Iron steamships began to replace wooden sailing ships.
1875	Transcontinental railroads were built. Coal was replacing wood as the fue for locomotive steam engines.
1876	The United States Centennial was celebrated with a huge Exposition in Philadelphia. The display featured gas stoves, electric lights, gasoline engines, mechanical farm equipment, and the new Bell telephone. A huge steam engine ran acres of machinery.
1879	Thomas Edison's light bulb and his first electric generating plant in New York City made electricity a success.
1880s and 90s	Electric turbine generators began to replace steam engines for running machinery. A turbine generator could use water power or steam from burning fuel to make electricity.
1885	Coal passed wood as the number one source of energy in the United States.
1895	The first large hydropower plant in the United States was built at Niagara Falls. The first long distance transmission lines were run from there to Buffalo.
1903	The Wright brothers made the first successful motor-driven airplane flight.
1905	Albert Einstein's ideas about energy encouraged research on nuclear energy.
1908	Henry Ford's Model T car made gasoline transportation cheap enough for many people to afford.
1910s to 1930s	Homeowners switched to central heating and began to buy electric appliances.
1920	World War I encouraged the development of airplanes.
1920	Huge natural gas fields were opened up, and bottled gas became available in rural areas.
1920s and 30s	Large electric generating plants, long distance transmission lines, and gas and oil pipelines provided more energy for more Americans.
1930s and 40s	Many synthetic products from coal, oil, and natural gas were developed: plastics, synthetic rubber, synthetic fabric.
1945	The United States and its allies won World War II on oil. As Germany ran out of fuel, Allied planes, jeeps, and tanks moved in.
1950	Oil passed coal as the number one fuel. The United States began to import more oil than it exported.
1957	The first nuclear-energy-powered electric plant was built.
1960s and 70s	New inventions, from computers to lasers to frost-free refrigerators, made the need for energy grow.
1970	Citizen concern for the environment led to new laws to control energy production and use.

1973	The Organization of Petroleum Exporting Countries (OPEC) cut off oil shipments to the United States for six months. Prices for oil and oil products rose.
1970s	Laws were passed to encourage energy conservation. Homeowners and businesses experimented with the use of sun, wind, wood, and refuse for energy.
1979	The oil supply was again threatened by the revolution in Iran. In the same year, an accident at the Three Mile Island nuclear power plant in Pennsylvania shook public confidence in nuclear energy.
1980s	Research continues on new—and old—sources of energy.
1986	A severe accident occurred at Chernobyl Nuclear Power Plant number 4 in the Soviet Union.

25. PREPARING ENVIRONMENTAL IMPACT STATEMENTS

Introduction:

The enacting of the 1970 National Environmental Policy Act (NEPA) set into motion the most far-reaching environmental legislation in U.S. history. In this lesson, students learn about one aspect of that law—the preparation of environmental impact statements.

Objectives: Students will be able to:

1. Describe the purpose of an environmental impact statement and the steps in its preparation.

2. Practice research and questioning skills in preparing an environmental impact statement.

3. Appreciate the role of various scientists in preparing environmental impact statements.

Subject/Grade Level: Civics/grade 9; geography/grades 9-10; economics/grade 12; environmental studies/grades 9-10; biology/grade 10

Time Required: 3 class periods

Materials and Preparation: Read the **Teacher Background Information** and prepare a brief presentation on the material. An overhead transparency of the Picnic Point Beach map would be helpful for the oral presentations. Make one or two copies of Handouts 25-1 and 25-2 for each group of three to five students.

Procedures:

1. Tell students about passage of the NEPA, explaining that this act mandated preparation of environmental impact statements for projects that could affect the environment. Discuss the purpose and process of the EIS.

2. Divide the class into groups of three to five students. Distribute Handout 25-1 and read through it with the students. Tell students that they will be acting as consultants on the Picnic Point Park project. Each team is to develop an EIS from data that will be provided. As a final step, they will present their EIS to a Department of Ecology panel.

3. Distribute Handout 25-2 and allow the balance of the period for teams to work. Some time at the beginning of the next class period should be allowed for completion.

4. Begin the hearings by selecting one member from each team to sit on the Department of Ecology panel. Have each group present its findings. Panel members may question the presenters on the accuracy of data and interpretations in the EIS.

5. When all the groups have made their presentations, discuss the presentations as a class, asking such questions as:

- How did the statements differ in their assessment of the significance of the environmental impact, the alternatives they propose, and the evaluation of the short- and long-term benefits of the proposal?
- Did each group consider the impact differently?

Source: Adapted from *Supplementary Activity Guide for Grades 7-12* (Washington, DC. American Forest Council, 1987). Reprinted with permission of the American Forest Council. Copyright 1987 Project Learning Tree.

- Did you expect all the groups to reach the same conclusion? Why or why not?
- What scientists would contribute to an actual EIS on the proposed project?

Evaluation:

Group presentations and student participation in the debriefing discussion can be assessed.

Extension/Enrichment:

Students can collect data on proposed local projects or examine impact statements developed on other local projects.

Teacher Background Information:

On January 1, 1970, President Richard M. Nixon signed into law the National Environmental Policy Act (NEPA), the most far-reaching environmental legislation ever enacted. NEPA created a new preventive mechanism for dealing with environmental problems. The heart of NEPA is found in Section 102. This section requires that all federal agencies prepare a "detailed statement" on "every recommendation or report on proposals or legislation and other federal actions *significantly* affecting the quality of the human environment." Specifically, these statements, now known as Environmental Impact Statements (EIS), are required for all projects directly undertaken by federal agencies; supported in whole or in part by federal agencies, contracts, grants, subsidies, loans, or other forms of assistance; or requiring a federal lease, permit, license, or certificate, which meet the "significance" test.

Since EISs are intended to assess the impact of a proposed action, a draft statement must be prepared at least 90 days before the proposed action for review by appropriate federal, state, and local agencies as well as the public. Once a statement has been prepared and reviewed, comments received during the review process must be answered. A final statement, incorporating all comments and objections and their resolutions, must then be made public at least 30 days prior to the proposed action.

If any of the reviewing agencies or members of the general public feel that the prepared statement is inadequate, they may file a court suit to require further research into the project's environmental impact. An EIS's adequacy and completeness is then determined through traditional judicial procedures. If the EIS is found inadequate, it may be revised and resubmitted. If the statement is deemed adequate, the proposed action may proceed. However, if the predicted consequences are seriously detrimental, further litigation may be brought to prohibit the proposed action.

Environmental impact statements are not intended to be justification for proposed funding or action. They are simply detailed presentations of the environmental impacts of and alternatives to the proposed project. The EIS is not intended to screen alternatives solely on the basis of environmental impact. They are prepared to ensure that environmental amenities as well as technical and economic considerations and public desires are equitably considered.

GUIDELINES FOR PREPARING AN ENVIRONMENTAL IMPACT STATEMENT

I. Description

A. Describe in qualitative and quantitative terms all biological resources and water resources. This discussion should include how the biotic communities have adapted to the physical environment and should also include the hydrologic cycle of adjacent water bodies.

B. Describe the soil characteristics and geology in the project area.

C. Describe all natural resources in the project area, including wilderness areas. The statement should recognize that these wilderness areas are a diminishing resource.

D. Describe existing air quality and any applicable standards or regulations.

E. Include graphic and pictorial information.

F. Describe meteorological conditions in the area.

G. Describe past, present, and proposed land use.

H. Describe accessibility to planning area. Include transportation plans.

I. Describe the socioeconomic situation in the community.

II. Environmental Impacts

A. Discuss impacts that may occur to water quality, air quality, noise, solid waste disposal, and pesticide use.

B. Discuss the impacts the project will have on the physical environment such as soils, geologic formations, hydrology, drainage patterns, etc.

C Discuss methodology to be used to minimize adverse environmental impacts. Where abatement measures can reduce adverse impacts to an acceptable level, the basis for considering these levels acceptable must be outlined.

D. Discuss the economic impacts of the proposed action.

III. Alternatives

A. Discuss the full range of management alternatives considered in the course of planning the action. The null alternative (the alternative of taking no action) must also be evaluated.

B. Discuss why the proposed alternative was chosen.

C. Discuss alternatives in sufficient detail so others may realize secondary or long-term environmental impacts.

IV. Short-Term Use Vs. Long-Term Productivity

A. Discuss environmental impact and economic costs and benefits as they relate to short-term uses and long-term productivity.

B. Discuss how actions taken now will (or will not) limit the number of choices left for future generations.

V. Irreversible and Irretrievable Commitment of Resources

A. Discuss resources to be utilized and what the replacement potential of these resources is.

PICNIC POINT PARK

1. The situation: A point of land on nearby Balsam Lake (a federal water impoundment) has been a favorite informal beach for many years. The point is easily accessible, although a railroad track on private property must be crossed to get to the beach. The point has considerable use because it is one of the few public beach areas easily reached by residents of the surrounding area. Last year it received 30,000 visitor-days of use.

After several meetings, the Bureau of Reclamation, which administers the area, has decided that Picnic Point should be proposed as a recreational beach site. An EIS must be submitted because the proposed development will be funded by federal money. Responsibility for preparing the EIS rests with those making the proposal, in this case the Bureau of Reclamation. The EIS will be reviewed at a public hearing held by the Bureau to meet NEPA's requirements.

2. The existing environment: Physical features of Picnic Point include a sandy-gravel beach; a creek running through the park area and emptying into Balsam Lake; and an area graded, but not yet surfaced, for a parking lot.

Biological characteristics to be considered relate to the lake, the land, and the creek. Balsam Lake is a large, quite deep, human-made lake. It is now relatively unpolluted and contains several kinds of fish, with trout the most abundant. However, the water quality is beginning to show some signs of deterioration, possibly because untreated sewage enters the lake from homes and summer cabins on the shore. The lake's edge has algae attached to large pebbles and boulders. This attracts algae-eating animals and their predators. The shallows serve as a breeding area and habitat for several kinds of animals. Water birds also are lake residents.

The land area once was covered with a forest of western red cedar and hemlock. Since these trees were logged off 50 years ago, bigleaf maple, red alder, a few Douglas firs, and a wide variety of berry and flowering plants have grown up to cover the site.

Picnic Creek is a fast-flowing stream, not very wide or deep. When it floods, it carries silt from bank cuts, sand, and some larger debris into the lake. The water generally is clear and of high quality except for excess numbers of Coliform bacteria; the bacteria count is two to three times the number safe for human use.

3. Proposed park development: The development of Picnic Point would include these features:

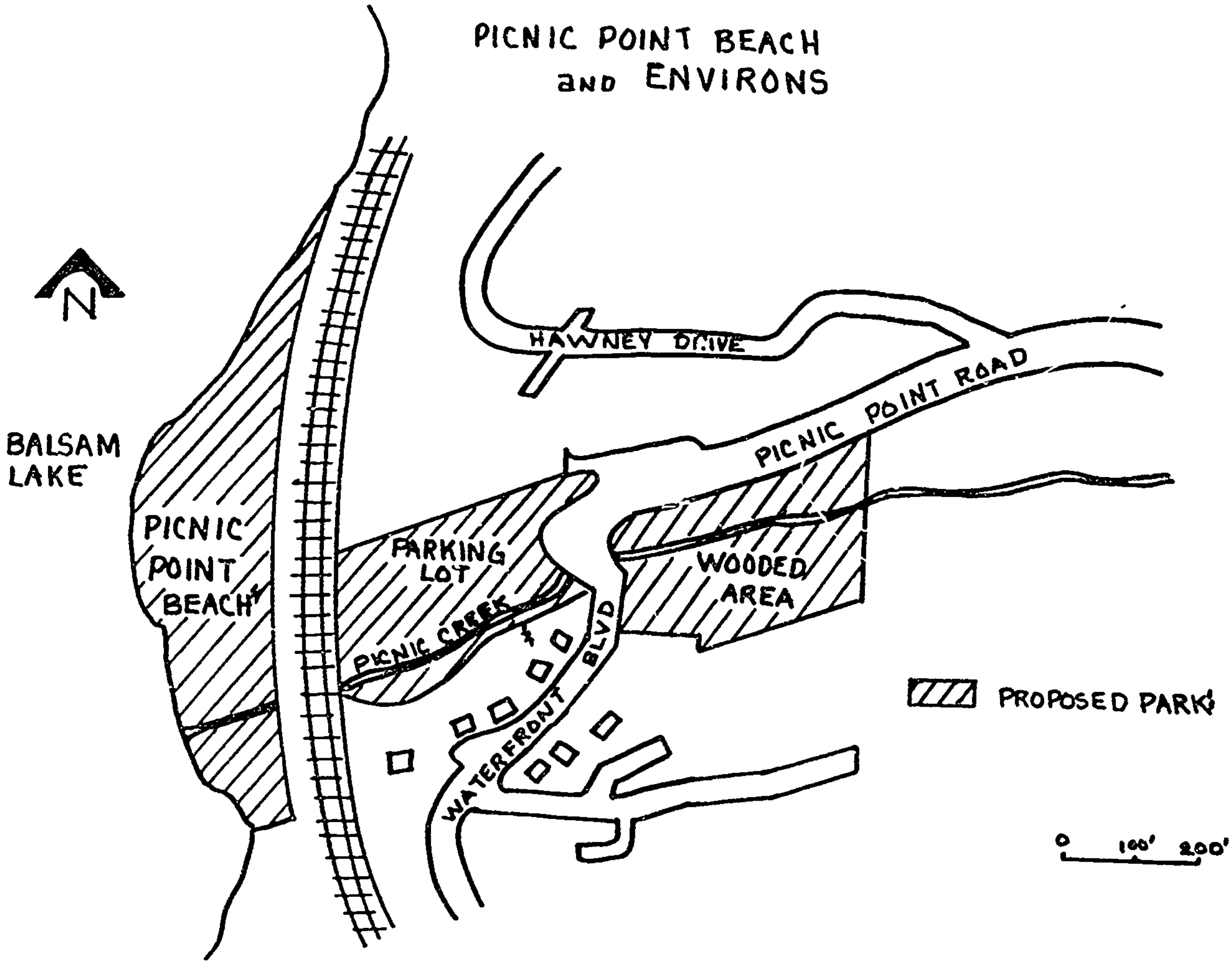
Construction and maintenance of an asphalt parking lot for 48 cars, with a bus stop and turn-around; concrete restrooms; a pedestrian railroad underpass 35 feed long, 10 feet wide, 8 feet high, and 4 feet below the tracks; a picnic area on the sandy land between the beach and the railroad; a gravel fill to protect existing trees along the railroad track; walkways; landscaping for shade and sand and soil stabilization; and a settling basin for Picnic Creek located just east of the railroad tracks.

Rules prohibiting camping; horseback riding; motor vehicles; log cutting; fires except in designated facilities; unleashed dogs; excessive noise or congregating of groups; pop-open cans; and damage to vegetation, soil, sand, facilities, or native animal life.

4. Design considerations: The development must have plans for sewage disposal from restrooms. Ideally this would be accomplished by building a lift station and force main to transfer sewage to the community's new treatment plant now under construction about 3,600 feet from the restroom location.

The design also must allow for sealed catch basins in the parking lot to prevent hydrocarbon run-off into Picnic Creek and consider the flow increment added to the creek by water run-off from the new asphalt parking lot. Although a large flow is not expected, actual data is unavailable.

The development of the beach area is expected to increase its use from about 30,000 visitor-days annually to 47,000. Facilities must be designed to meet the needs of this greater use.



26. THE FREEWAY PLANNING GAME

Introduction:

This simulation deals with the competing values of various interest groups in deciding the route for a new freeway. The exercise demonstrates that no objective, value-free measure of choices is possible.

Objectives: Students will be able to:

1. List factors to be considered in locating a freeway.
2. Explain choices in terms of the effects of the choices.
3. Describe the process of planning public works.
4. Appreciate the value of negotiating to reach a conclusion satisfactory to several groups.

Subject/Grade Level: Civics/grade 9; geography/grades 9-10; government/grade 12; economics/grade 12

Time Required: 1 class period

Materials and Preparation: Make copies of Handout 26-1 for all students. You will also need a large number of Handout 26-2—perhaps 80-100 copies. The lesson can consume several maps per student if they are simply run off. More durable, reusable maps can be made by taping each map to a piece of cardboard, then laminating them with clear plastic. Distribute crayons and tissue with the laminated maps. You may also find it helpful to have a transparency of the map projected during the simulation.

Teachers may want to examine newspapers for local eminent domain and other land use issues that would help personalize this activity.

Procedures:

1. Divide the class into six groups. Assign each group a role:
   - City Council
   - Taxpayer's Association
   - University Archaeologists
   - Resident's Association
   - Merchant's Association
   - City Engineers

2. Distribute Handout 26-1. Review the assignments and the scoring rules. Distribute several maps to each group. Work a couple of sample scores to clarify the rules. Allow 10-15 minutes for the groups to plan, draw, and score their routes. Collect one master map from each group.

3. Regroup so that each new team has at least one member from each special-interest group. This is most easily done by counting off (in a class of 30 there will now be 5 groups of 6 students; in a class of 25 there will be 4 groups of 6).

Source: Adapted from *Michael Chester's Freeway Planning Game* (Del Mar, CA: Simile II, n.d.). Reprinted by permission of the publisher.

4. Allow 10-15 minutes for mapping and scoring. Collect one master map from each group and post scores.

5. Debrief by discussing the differences in scores and in the decision processes used in the two types of groupings. In which type of groups was the decision making easier? Why? What process did you use to arrive at your decisions? Which version is closer to real road planning sessions? How often did the archaeologists (as the most specialized and narrowly focused group) "get their way"? What might happen as the area affected by a road broadens (from city to county, etc.)?

Evaluation:

Ask each student to make a list of "tips for road planning." These should include substantive concerns as well as strategies for negotiating.

Extension/Enrichment:

1. The lesson can be expanded by providing each group with a transparency copy of the planning map. After they have made all of their decisions, have them transfer the recommended route onto the transparency. Each group then presents their plan to the class as though they were trying to convince a county planning board. You may want to have a panel of studr ts act as such a planning board, choosing among the proposals.

2. Students interested in simulation gaming may want to examine the assumptions in the scoring grid, then go on to construct their own simulations.

ASSIGNMENT SHEET AND SCORING RULES

The Task

You are part of a group of experts brought together to suggest a route for a new freeway across Chester County. As you can see from the map, Chester County is rich in history and is geographically diverse. Its economy is healthy. The new freeway will provide a much-needed thoroughfare for the state's growing population and commerce. Just north of Chester County the new state hazardous waste dump is being constructed.

Step 1: Meet with your consulting peers. Read the rules carefully. Consider the following questions. Then plot out your route. Determine your total points and turn in a master copy.

- What are the goals of your special-interest group?
- Which of those goals are you unwilling to compromise in the event of resistance?
- How does the Scoring Chart reflect those values?

Step 2: When directed to, regroup. The new group will include a mixture of different types of experts. As a group you must come to a decision on the route. Consider these questions as you work:

- How are you going to make decisions?
- Who will fill the roles of mapmaker, presenter, mathematician?
- If there is more than one of a particular type of expert in your group (e.g., two merchants), do they get more consideration in weighing decisions?

Plot your route, total the points, and turn in a master copy.

The Rules

You are to select a freeway route that runs *from* any one of the *bottom-most hexagons to* any one of the *top-most hexagons*. Plan your freeway so it will cost the fewest points possible. The *lower* your score, the better. *Each* expert must keep his/her own score.

Scoring:

Each hexagon you enter costs 5 points.

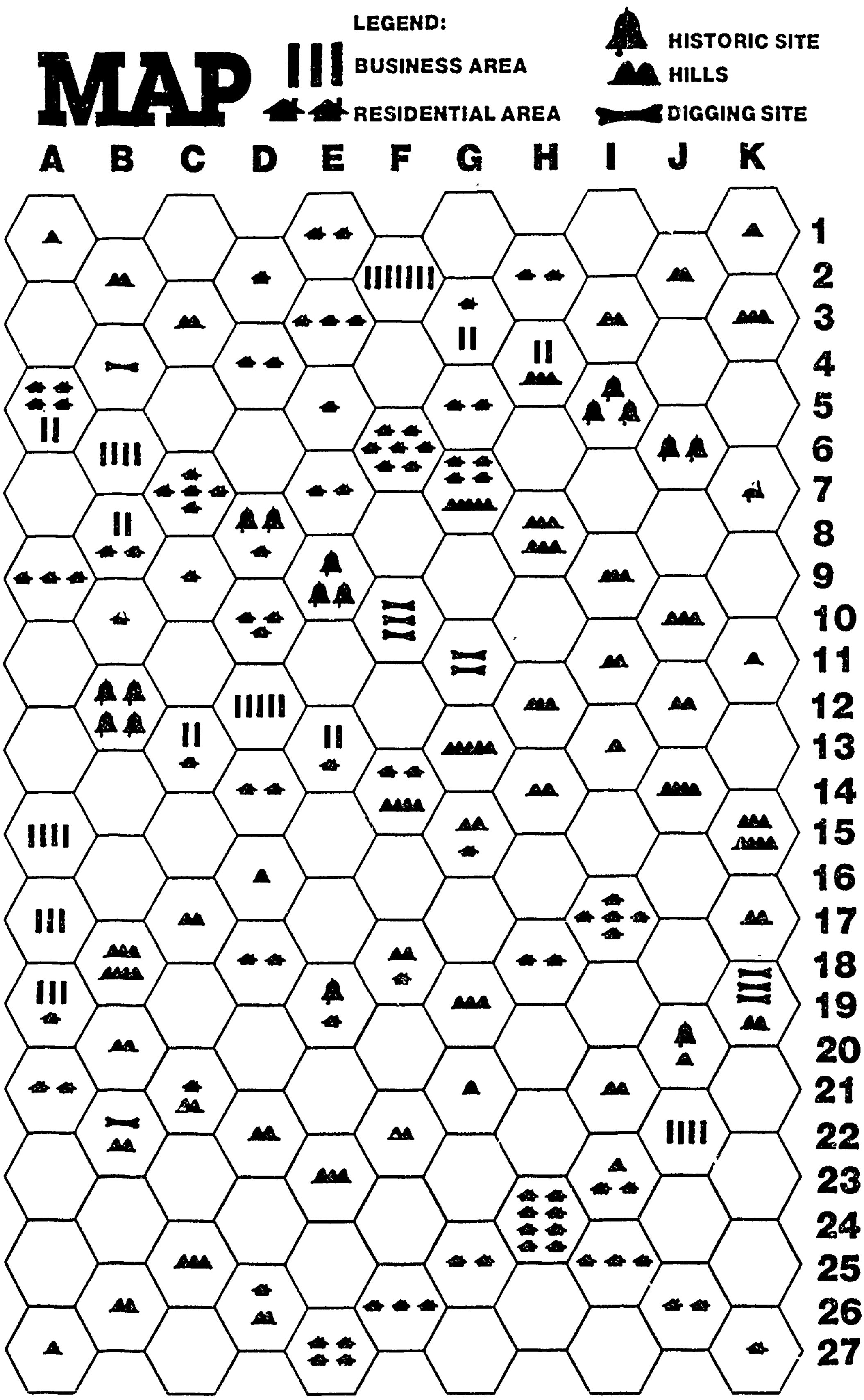
Each symbol costs a point penalty as shown in the scoring chart. Note that the points are different for each expert. (For example: When you enter a hexagon containing 2 hills and 1 business, engineers must add 20 points to their score—5 points for the hexagon, 7 points for each of the hills, and 1 point for the business.)

After your route map is complete, total each person's point penalties. Add all of the individual scores together to obtain the group score. Record the score on the master map and turn it in.

Scoring Chart

City Council	5	3	1	1	1
Archaeologists	1	1	1	3	5
Taxpayers' Association	1	3	5	1	1
Residents' Association	7	1	1	1	1
Merchants' Association	1	7	1	1	1
City Engineer	1	1	7	1	1

CHESTER COUNTY Group # ____________________ Total Score ____________



27. THE ORGAN HUNTER

Introduction:

More than 100,000 organs have been transplanted into needy patients over the past 20 years. The success rate for these transplants is over 75 percent. Yet, perhaps as few as 15 percent of all potential donors actually provide organs. To improve the donation rate, specialists in organ procurement have emerged. This lesson examines one of those specialists and the issues he deals with daily.

Objectives: Students will be able to:

1. Explain the process of obtaining donated organs.

2. Identify various issues involved in obtaining donated organs.

3. Appreciate the need to consider ethical questions in the organ donation process.

Subject/Grade Level: Government/grade 12; current events/grades 8-12; life science/grade 7; biology/grade 10

Time Required: 1-2 class periods

Materials and Preparation: Make copies of Handouts 27-1 and 27-2 for all students. An overhead transparency can be made of the **Teacher Background Information** as an optional aid.

Procedures:

1. Introduce the topic of organ transplants. Question students about where and how they think doctors obtain the transplant organs. What kinds of problems or issues might be involved with obtaining organs? Elicit from students enough responses to cover the topics on Handout 27-1.

2. Distribute Handouts 27-1 and 27-2. Allow 15 minutes for reading and working on the chart. You may want to read the article aloud with the class.

3. Debrief the reading by discussing the issues students have identified. The **Teacher Background Information** may be projected as an overhead to help answer some questions. All 50 states have enacted the Uniform Anatomical Gift Act. This act provides for a wallet-sized donor card, signed and witnessed by two others, that allows surgeons to remove organs from the brain-dead body. Other states have systems for pledging organs as part of the driver's license renewal process.

4. Have students pick the single issue they see as most important. Then assign groups to various positions on the issue and have them prepare for a brief debate on the issue. After the debate, each student should write a short essay explaining how the issue might be resolved and what impact the resolution would have on organ transplants as a whole.

Evaluation:

Students' essays can be used for evaluation purposes.

Extension/Enrichment:

Have students find articles about organ recipients and the families of organ donors. How do these participants view the ethical issues discussed in this lesson?

Resources:

Long, Brendan, "Vital Facts About Organ Transplants," *Consumers' Research* (May 1986), pp. 28-31.

Revkin, Andrew C., "Organ Hunter," **Discover** (February 1988), pp. 64-69.

Schnieder, Andrew, "Organ Procurement Teams Rush New Life," *Pittsburgh Press* (May 26, 1985), pp. 18+.

Teacher Background Information:*

How many organ transplants have been performed and what is the average cost for each procedure? What is the survival rate for each? How many people are waiting for organ transplants?

Organ	Transplants Performed In U.S. 1981	1982	1983	1984	Average[1] cost	1-year patient survival rate	Number of people waiting for transplantation
Heart	62	103	172	346	$ 57,000-110,000	80%	100[5] (approx)
Kidney	4,885	5,358	6,112	6,968	22,000-30,000	91[3] 96[4]	8,000[6] (approx)
Liver	26	62	164	308	135,000-238,000	65	300[7] (approx)
Pancreas	–	35	61	87	30,000-40,000	35-40	30[8] (approx)
Corneas	–	18,500	21,250	24,000	7,000[2]-7,000	90 (Success rate of cornea graft)	4,000 (approx)

[1]Many variables account for range of cost in transplantation procedures – lack of uniformity in reporting component costs, complications, medication regimen, method of reporting or non-reporting payment of surgeons (salary, fee, no charge), graft rejection, readmissions, infections, geography.
[2]Outpatient procedure average cost is $4,000-$5,500. Inpatient procedure average cost is $5,000-$7,000; 2-3 day inpatient stay maximum.
[3]Transplant with kidney from deceased donor.
[4]Transplant with kidney from a living related donor.
[5]According to the National Heart Transplantation Study conducted by the Battelle Human Affairs Research Centers, 15,000 people could benefit from heart transplants.
[6]May include some duplicate counting due to some patients being on more than one kidney transplant waiting list or including some patients who were not removed from waiting list after transplant.
[7]According to the National Heart Transplantation Study conducted by the Battelle Human Affairs Research Centers, 8,500 could benefit from liver transplants.
[8]According to the National Heart Transplantation Study conducted by the Batelle Human Affairs Research Centers, 5,000 could benefit from pancreas transplants.

*Source. *Consumers' Research* (May 1986), pp. 28-31. Reprinted by permission of the publisher.

ORGAN DONATION ISSUES

As you read the "Organ Hunter," use this chart to list as many different organ transplant issues as you can for *each* category.

Economic	Political	Technological	Religious	Medical	Legal	Other

ORGAN HUNTER

By Andrew C. Revkin

Bill Cantirino is home in Brooklyn on a Tuesday night, relaxing after dinner, when a shrill beeping sound tells him there is work to be done. He turns off the electronic page on his belt and is soon on the phone with a doctor at nearby Maimonides Medical Center. The doctor says they have a man in intensive care who looks ideal. He was carried into the emergency room the night before with a bullet in his neck.

Two policemen said the man had tried to gun them down after they pulled over the stolen Cadillac he was driving. They had both opened fire. The bullet cut a carotid artery, one of the main sources of blood to the brain. A surgeon worked for five hours trying to piece together the torn artery while others tried to keep the man alive. They finally stabilized him, but they were too late. His body was being kept alive on a variety of machines, but his brain had died.

Cantirino gets the name of the man's family and says he'll be in the next day. He thanks the doctor and hangs up the phone.

For Cantirino, tragedy means business. In an average week he has two or three such conversations. As one of two organ hunters for the Gift of Life Organ Procurement Organization, he is on 24-hour call, waiting to get word of potential organ donors. In the past decade, new drugs that prevent the body from rejecting foreign tissue, improved tissue-matching techniques, and better patient care have made organ transplantation less a risky experiment and more a standard therapy following the failure of one of the body's vital components.

The nonprofit Brooklyn-based group, part of a growing nationwide organ-sharing network, seeks hearts, livers, corneas, even skin. But its stock-in-trade is kidneys: 8,796 kidney transplants were performed in this country in 1986. There were another 10,000 people with kidney failure on waiting lists for transplants. And 11,000 new cases develop each year (2,000 of those are patients who have already received and rejected a first kidney transplant).

Kidney-failure patients can be kept alive by dialysis, the periodic cleansing of their blood. This can be accomplished with an artificial kidney, but that's expensive, generally requires three four-hour sessions a week, and involves restricted diet and activity. In another form of dialysis, a tube is inserted through the wall of the abdomen, into the abdominal cavity, and waste-absorbing fluid is pumped through and then removed. Both forms of dialysis require a lifetime of intrusive treatment.

The problem is that the demand for organs now far exceeds the supply. Patients waiting for transplants of vital body parts must wait for an anonymous death and for people like Cantirino to go to work. His job calls for him first to locate a special kind of death--a death in which the brain is completely destroyed but the body hangs in a sort of limbo, sustained with machines and drugs but never able to be resurrected as a living person. Such deaths are usually caused by physical trauma to the head or lack of oxygen.

Deaths that make for good organ donors are therefore usually of the unexpected kind—the result of car accidents, shootings, or suicides. Once he has located such a case, Cantirino must try to convince parents or children or spouses in the depths of grief to donate organs from the deceased. Cantirino has to be a diplomat and psychologist, social worker and undertaker, rolled into one. He is often asked why he does such a thing. And his reply is always the same: "Because I was once given a second chance." Twelve years ago a kidney transplant saved his life.

Source. Excerpted from *Discover* (February 1988), pp. 65-59. Reprinted by permission of the publisher.

On Wednesday morning Cantirino calls the family of the shooting victim and arranges to meet them at the hospital that afternoon.

He drives to Maimonides hospital early, to get a look at the prospective donor and to talk things over with the hospital staff. He says he can afford to give this family a few days to make up their mind. "As much as I would want the kidneys tonight, I would never press the family," Cantirino says. "I would never make it a point of saying, 'Look, if we don't get them now it's too late.' I would rather lose them and walk away."

In 1974 his kidneys began to fail. He went on dialysis but suffered recurring infections, and the frequent sessions proved ineffective. He was told he would have to have a transplant. On March 27, 1975, Cantirino received a kidney from a murder victim, and the detective's story made the front page of the New York *Daily News*. But the new kidney failed. Had a second transplant not been arranged, the failure of the first could have killed him.

In December Cantirino received another kidney, this one donated by his sister. Because kidneys come in pairs, it is possible to take one from a living donor, but the donor generally must be a close relative. This second transplant worked. Cantirino was lucky. Only a small percentage of kidney-failure patients have a living relative with a compatible tissue type. (And then, of course, not every compatible relative is able to or wants to give up a kidney. In 1986 1,887 of the 8,976 transplanted kidneys came from relatives.)

In 1979 Cantirino retired from the police force, and Khalid Butt, the surgeon who had implanted his kidneys, offered him the job of organ hunter.

In the small intensive care unit on the fourth floor of Maimonides hospital, Cantirino meets with the young doctor who called him the night before. Cantirino says he has developed personal contacts in emergency rooms and intensive care units throughout New York City; it helps speed the search.

Their attention now turns to the prospective donor. The doctor produces a blue folder labeled "Patient Record Number Eight." Cantirino thumbs through page after page of scribbled entries—blood pressure, heart rate, doses of dopamine and other drugs, electrocardiograms, and electroencephalograms. "Looks good," he grunts. "Good donor."

Cantirino walks out from behind the nursing station and down the row of patients. A plastic rose stands in a bud vase on the counter. A transistor radio plays country music. The shooting victim is in the second bed. His chart says he is 24, but he looks younger. He lies with his eyes half closed, perfectly still except for the slow rise and fall of his chest. He is naked, loosely covered by a cotton sheet. His body is a bit chubby, his sideburns long and uneven. There is a Playboy bunny tattooed on his right biceps. An array of tubes runs down his throat and nose, and others rise from needles in the crooks of both arms. Two pale-blue corrugated hoses run from his mouth to a mechanical respirator by the bed. They quiver in synchrony with the hiss and motion of a black rubber bellows on top of the machine.

A nurse tells Cantirino that the family is out in the hall—a few cousins and uncles, the victim's parents, and his sisters. "Most of our cases are either gunshot wounds or auto accidents," Cantirino says. "This is typical of how you have to deal with a family, because there's a guy who all of a sudden goes out. It's not a case of where he had been sick or something."

Cantirino greets them and leads the immediate family into an empty conference room. Three sisters sit stiffly along one wall. The mother, a small, birdlike woman, sits opposite Cantirino, at the far end of a long walnut table. She sits sideways in her chair. No one looks directly at anyone else. The father sits to one side, overdressed in a heavy camel hair coat and a hat pulled down low. He periodically adjusts his brown-tinted glasses and stares at an empty blackboard.

Cantirino begins his pitch slowly, speaking gently. He says the doctors did all they could do. There is no hope. Repeating words already delivered to the family by a doctor, Cantirino says, "Your son is dead. The brain is gone completely. He lost so much blood that there was no oxygen to the brain. And the brain, when it's deprived of oxygen, it dies."

Cantirino carefully punctuates his delivery with pauses, giving the family time to absorb the blows. He tells them an electroencephalogram, or EEG, a test of the brain's electrical activity, was done that day. He says it was "flat-line" for at least a half-hour – not even a spark of life. Two doctors had independently confirmed that their son was brain-dead.

"The only good that can come out of this is that two people can have a new life," Cantirino says, now shifting to a positive tack. "It could be anybody from the age of three to the age of fifty. It could be a woman with children; it could be a girl getting married."

The only sound is the humming of an electric clock. "I don't know if you know anybody on dialysis, but it's not very pleasant," he says. "This is the only chance these people have to have some sort of life." The victim's mother hardly moves. She stares at the metal legs on one of the plastic chairs. "It's a very hard thing to ask you people, when you are losing a life, to give someone else a life," Cantirino says. "But it's the only time it can be done."

There is a long silence, finally broken by the father. "I know what it is all about, these things," he says. He speaks with a Spanish accent, slowly hefting each word like a heavy object. Cantirino, seeing he has gotten them over the first big hump, starts to lay out the situation in more detail. He says there will be an autopsy, as in any gunshot case. Giving up the kidneys will not affect any legal situation. (A sister had told him that there would be a grand jury investigation of the shooting.)

"This is a very hard decision," the father says in a monotone.

"I'll grant you, it's not an easy one," Cantirino says. "If you look at it from the point of view that someone will be helped, then maybe it would be a little bit easier. But this is something that you have to work out yourself. I just want to tell you why we need them, who they would help."

The father rises slowly, almost painfully. "I understand you perfectly," he says. His wife moves to his side. Cantirino hands the father a business card and tells them to go home, to think it over. The door closes behind the couple, leaving Cantirino alone in the silent room.

He returns to the intensive care unit to tell the doctor that it will be at least two or three days before they get a decision. "They've just been told their son is dead," Cantirino says. "Regardless of what he did, he's dead. Now they have to accept this, to come to terms with it. Then they have to say okay – which I think they might, because we didn't get a flat no. The father seems to be the strong one, yet the mother's the one who holds the key. You can see just by looking at her that no matter what he wants, she's the one who'll say, and whatever she says will go."

By the next afternoon nothing has changed. The victim is still stable, although he is passing a lot of fluid, a nurse says. A rookie policewoman, assigned to guard the victim – who is technically a prisoner – sits idly flipping through a thick novel. As Cantirino passes he smiles at her, recalling his police days. "It's better than walking a post," he says of her bedside duty. She smiles back.

The family is due at noon, but they don't show up until midafternoon, and then it's just the three sisters. The shock seems to have dissipated somewhat, but it has been replaced by suspicion. They start to ask questions. Where will the kidneys go? Are they sold or given to anyone who needs them? When will the body be turned over to the family?

Cantirino carefully, patiently answers each question. The body will go to the Office of the Chief Medical Examiner of New York City. Because matching an organ donor with a recipient is first attempted locally, the kidneys will probably go to someone from Brooklyn. "It's people like us," he says.

He says there are almost 500 people on the waiting list at the State University of New York Health Science Center alone (the Brooklyn hospital is the ninth-busiest kidney transplant center in the United States).

A match is made from a list of potential recipients at New York's various transplant centers. The selection is based on the length of time a patient has waited, the direness of the need, and the degree of tissue compatibility. "No one can buy a kidney, rich or poor," Cantirino says. "It's strictly through luck." Cantirino calls in their brother's doctor.

The doctor's boyish face, open collar, and deck shoes belie his authority as chief resident. He begins applying pressure. He says the number of bullets that struck the victim will be learned from the autopsy. But as far as the possibility of donating organs, it is becoming a question of time. In a day or two, or maybe a week at the most, infection will set in. And soon, the doctor explains, because of the demand for beds in the intensive care unit, their brother will have to be moved to a general ward, where the care is not as good.

Cantirino interrupts, sensing the pressure is becoming too intense. "The body on a machine doesn't really function. It's not normal. The liver, the kidneys themselves, they don't perform the way they should. And the body starts to accumulate poisons in the blood. You can't maintain the body," he says softly, "because it's not normal." The oldest sister twists the leather thongs on her purse as he talks. She has run out of questions. The sisters say they will go home once more and talk it over with their parents. The youngest one says their mother will decide. Cantirino asks them to try to decide by tonight.

"It's never a sure thing," Cantirino says after they have left. "I've had them change their mind. Had one on the way to the operating room and they changed their mind. Then they came back the next day and said okay." He says his job is made difficult by a lot of things: a lack of public awareness, misinformation in the form of sci-fi films and novels. "When they showed *Coma* in Boston," he says, referring to the popular film about a hospital that killed patients to get organ donors, "they went forty-three days without a donor."

Cantirino says another problem is the lack of a federal law making brain death the legal equivalent to the traditional definition of death. Forty-two states and the District of Columbia have passed such laws, and in six states, court decisions have forged legal definitions for brain death. But as long as there is no consistency, he says, there will be confusion and fear among both physicians and the public.

Even so, the situation has improved dramatically since Cantirino began his job in 1979. Then, he says, only one out of five families would give consent. His average is now three out of four. Extensive publicity of some transplants has helped, as have publicity campaigns by local hospitals. A newly enacted federal law requiring all hospitals to identify potential donors is increasing the chances of getting organs. Cantirino and his partner, physician John Evangelista, had 130 donors in the first 11 months of 1987; that's up from 32 in all of 1979. "At least now they know what you're talking about," Cantirino says of the families he has met with.

Thursday night the sisters return with their mother, who is now dressed in black. She sits in a chair in the hallway, beneath a cheap print of yellow flowers that hangs on the cinder block wall. The doctor stands to one side, talking quietly with a friend of the family's. Cantirino hands the consent form to the mother. She and her daughters read it slowly. At 7:50 P.M. the mother signs the paper, indicating that she speaks for her husband as well. The doctor signs the form and makes a final entry on the patient's chart: he pronounces him dead.

The family goes for a last look at the victim-turned-donor. There are a few sobs, but mostly silence. After several minutes they leave for the last time. The young man lies still. An endless line of heartbeats parades across a monitor over his head. The bellows hisses, his chest rises and falls. A radio somewhere squawks tinny rock and roll.

Cantirino does some paperwork and telephones the organ recovery team at the Health Science Center. Within a day the kidneys will be sutured into place in the abdomens of two people. Cantirino heads for the door, his job done. A nurse waves to him, smiling. "Happy hunting," she says.

28. WARNING FUTURE GENERATIONS

Introduction:

Accumulation of nuclear waste products has generated several problems. The problem of how and where to store the materials has been addressed most seriously by the government. The debate on storage methods and locations continues, but a new concern has been raised. Even if storage containers and depositories are developed that are completely safe from the ravages of nature, how can they be made safe from the vagaries of humans?

This exercise asks students to create a sentry system designed to guard nuclear waste dumps from accidental compromise by human actions. The problem of designing a system that will last for 300 human generations will allow students to invent in the areas of linguistics, communication, architecture, art, and science.

Objectives: Students will be able to:

1. Explain the dangers of exposure to nuclear waste.

2. Create a system designed to warn humans of the dangers of exposure to nuclear waste.

3. Develop symbolic languages to communicate the dangers of exposure.

4. Create posters illustrating their physical plans and linguistic inventions.

Subject/Grade Level: Current events/grades 7-12; world geography/grade 7; government/grade 12; environmental studies/grades 9-10

Time Required: 2-4 class periods

Materials and Preparation: Make copies of Handout 28-1 for all students. Gather butcher paper, crayons, markers, dictionaries, and thesauri for use in the small-group work.

Procedures:

1. Divide the class into groups of four. These groups will remain together for the entire project.

2. Distribute Handout 28-1 and allow time for students to read the handout.

3. Answer questions about the assignment. Provide dictionaries and thesauri for reference materials and have students begin. The first day should be spent working on the linguistic aspects of the project.

4. During the second period, students should complete work on the linguistic project and begin brainstorming the monolithic aspects of their project. Encourage them to develop plans on scrap paper before moving to the large-scale posters.

5. In the remaining class periods, students should complete work on the posters. Hang the posters and have groups examine and attempt to interpret them. Conduct a discussion of the interpretations and have the class vote on the system that most successfully achieved its objective. During the debriefing, identify and discuss the ideas that worked the best to communicate the desired warnings.

Source: Adapted from John D. Haas and others, *Teaching About the Future: Tools, Topics, and Issues* (Boulder, CO: Social Science Education Consortium, 1987), pp. 73-76.

Evaluation:

Ask students to write a paragraph explaining why they voted for the system they did. Their paragraphs should explain how the system voted for achieved the project objectives.

Extension/Enrichment:

1. You may want to send copies of the most successful design to the school newspaper or to the U.S. Department of Energy.

2. Advanced classes might want to challenge the idea that warning systems have to follow the parameters provided. Let them explore other possibilities. They might also want to search for solutions to the underlying problem—the generation of nuclear waste—rather than deal with the symptoms.

3. Classes interested in the linguistic aspects of the project might write heroic legends that would contain warnings about the dangers of entering the disposal areas. These epics must be powerful stories to ensure that they impress the minds of future generations.

Resources:

Didsbury, Howard F., Jr. (ed.), *Communications and the Future* (Washington, DC: World Future Society, 1982).

Douglis, Carole, "Stone Sentry," *Omni*, Volume 8 (November 1985).

Gannes, S., "Sentinels for a Nuclear Tomb," *Discover*, Volume 5 (September 1985).

Herndon, James, *How to Survive in Your Native Land* (New York: Touchstone Books, 1977).

Holden, C., "Omens of Doom for Nuclear Waste Tomb," *Science*, Volume 225 (August 3, 1984).

"Nuclear Legends," *Harpers*, Volume 269 (October 1984).

"Warning Signals: How to Warn the 120th Century About Disposal Sites," *Time*, Volume 124 (November 26, 1984).

WARNING FUTURE GENERATIONS

"How do you talk to the future? Signs rust, documents crumble, buildings fall, languages change. Yet the markers for nuclear waste must warn 300 future generations."

From Carole Douglis, "Stone Sentry," in *Omni*, November 1985, page 64.

Imagine that beneath mounds of earth, acres of radioactive soil have been fused into black glass. Tanks of spent nuclear power plant fuel and high-level defense waste lie buried in deep salt mines. Damage to the protecting layers of earth and salt could release dangerous levels of radioactivity into the ground and the atmosphere. Threats posed by natural disasters have been controlled by careful engineering. The sole remaining challenge to the safety of the depositories is...humankind.

Radioactive wastes can remain dangerous to life-forms for as long as 3 million years. Even if the physical structures designed to lock in the radiation last that long, how can future generations of curious humans be prevented from penetrating that protection? Warning signs rust away. Books turn to dust. Buildings collapse. Most dangerous of all, languages change.

How can the present communicate such an important message to the future? Researchers have identified four elements essential to an effective long-term warning system:

1. Inanimate objects must communicate a clear and urgent caution.

2. The message must be sent in more than one way: the more redundancy in the system, the lower the margin for error.

3. Warning markers must be of monumental scale. The markers must be made of some massive, hard-to-move chunks of very low-value material. The size and low value prevent the markers from being carted off for other uses. There must be more markers than appear necessary. This will insure that some markers will remain, even if many are destroyed by weather, quakes, war, or other human actions.

4. There must be written records and warnings. The warnings must be understandable even to the illiterate.

While the principles of monumental engineering have been well understood for centuries, the dynamics of languages are more difficult. Studies show that languages change over time. About 19 percent of the basic words of any language change every 1,000 years. After 5,000 years English readers would understand only about half of today's common words. In 10,000 years the percentage drops to about 12 percent. The problem is to construct warning signs that will continue to communicate the DANGER! message in ways that will not lose their meaning with the passage of time.

Your team has been selected to design the nuclear hazard warning system for the United States. Read the instructions on the next page very carefully!

Instructions for Warning the Future

1. *Create a language that will resist change for 100,000 years. The most effective languages will use simple, clear symbols. These symbols must be understandable to all cultures. Cartoon- like drawings can be very effective.*

A. You must work with your group to devise a simple symbolic language that will be understandable to all people. Begin by generating a list of the words you think will be most important in your signs. Invent two or three different symbols for each word and then decide which best communicates the idea of each word.

B. Make a dictionary list on notebook paper. This will be turned in with your final packet.

C. Write *three different* warnings in your symbolic language.

D. Draw the three warnings on the poster paper.

E. Hang your poster on the wall. Do not translate your poster for any other team.

2. *Design a system to carry your warnings. Remember to follow the four rules of design on the first page of the handout.*

A. Design a system of warning monuments to guard the place where radioactive wastes will be stored. Be sure to include the locations of the warnings you have written in your symbolic language.

B. On the second sheet of poster paper, draw an aerial view of your monuments and a close up of one of the markers.

C. Hang your second poster next to your first one.

3. *Examine the posters from the other groups and try to decipher their symbols. Take notes on the systems that were the easiest to understand. What made the system work? Where was it weak? Which system do you think is most likely to last for 100,000 years?*

Due Dates: Language Dictionary ________________

Language Poster ________________

Monument Poster ________________

Sample Warning:

What does it say?

29. THE ENVIRONMENT AND PARTICIPATORY DEMOCRACY

Introduction:

This country was founded on the principle that each of its citizens has the right to participate in the policy-setting and decision-making processes. Then, as government bureaucracies grew in size and became more centralized, decision-making was left increasingly to the "experts." Recently, however, advocates have sought to regain some of their participatory rights. Nowhere is this trend more evident than in issues and policies affecting the environment. Early in the century, there were only seven national and two state conservation organizations. By 1960, these numbers had grown to 78 national and 236 state organizations.

This lesson is planned to help students understand the roles and responsibilities of government agencies and special-interest groups with regard to forest resource management, although the procedures are easily adapted for other applications.

Objectives: Students will be able to:

1. Name government agencies and special-interest organizations involved with environmental issues.

2. Understand the process for providing input into resource management policies.

3. Ask questions to obtain specific information.

4. Value citizen participation.

Subject/Grade Level: Civics/grade 9; government/grade 12, current events/grades 9-12, ecology/grade 9; environmental studies/grades 9-10

Time Required: 3-4 class periods

Materials and Preparation: Two or more weeks before the activity, you will need to identify the guest speakers and set up appointments. Speakers should represent one or more environmental groups and at least one government agency. Both types of organizations maintain lists of speakers. A variation of the activity is to have all of the speakers on the same day. To provide enough time, it may be desirable to schedule a two-period in-school field trip. If the panel format is followed, insure that all guest speakers know what to expect and who the other panel members will be.

Procedures:

1. A day or two before the guest speakers are scheduled, open a general discussion on citizen access to governmental policy-making. How do government leaders make decisions in areas where they are not expert? How do the experts get information to the government? While most of these questions can be answered from standard government texts, the realities of special-interest group politics often create results quite different from the textbook model.

2. Discuss the operations, methods, and general goals of special-interest groups. It should be pointed out that even the most narrow special-interest groups usually portray themselves as providing benefits to the larger society. Environmental groups experience the same political forces as other special interests.

Source: Adapted from *Supplementary Activity Guide for Grades 7-12* (Washington, DC. American Forest Council, 1987). Reprinted with permission of the American Forest Council. Copyright 1987 Project Learning Tree.

3. Inform students that they will be listening to presentations from one or more environmental groups and government agencies. As well as listening to the prepared talks, students will have the opportunity to question the presenters. On the board, post the names of the organizations that will be represented. Instruct students to work in pairs to devise a list of questions for the speakers. Have students strive to write five questions.

Sample questions are:

- What is your group's main objective?
- Is the organization statewide, national, or international?
- How many members does the organization have?
- Is membership growing or declining?
- Does the group lobby elected government officials? If so, how often and in what manner? What percentage of your annual budget is spent on lobbying activities?
- Does your group publish a newsletter or magazine?
- What technical expertise does your group have available?
- What is your group's annual budget?
- What are some of your group's major accomplishments?
- On what areas are you currently focusing?
- How does your group obtain its technical data?
- How did you determine a need for your group to exist?
- What are your most significant successes and failures?
- Describe your working relationship with the government bodies with which you interact. How effective, in your terms, is that relationship?

Questions for government agency representatives might include:

- What are your agency's responsibilities?
- Do these responsibilities overlap with those of other governmental agencies?
- If this is a federal agency, in what cabinet-level department is it included? Who is the department secretary? Who is the agency's director? Is the director elected or appointed? If appointed, by whom?
- What is the present director's professional background and how does it relate to the responsibilities of the agency? (For example, is the chief forester a professional forester?)
- What is the agency's annual budget and how is it allocated?
- Whose responsibility is it to see that the agency carries out the will of the public?
- How can the public make input into this agency's policy and decision?

Some suggested questions for industry representatives are:

- How large is your organization? (For a company, this could include its rank in national sales and the number of states in which it has operations; for an agency, the number of companies it represents.)
- How long has your organization been in business?
- Does your company (or association) lobby or in other ways attempt to influence legislation? If so, how much do you spend on lobbying in dollars or in percentage of sales or profit?
- Does your company (association) attempt to influence public opinion? How?

- What technical expertise do your employees have which qualifies them to deal with the areas of resource management in which your company (association) is involved?
- Have conditions or policies [illegible] urce management changed significantly since the beginning of the so-called [illegible] al decade"? What, in your opinion, caused these changes?
- What are the major environmentally related issues and problems facing your company (association)?

4. Discuss the questions and appoint a recorder to compile the best ones.

5. On the appointed day, introduce the guest speaker or speakers and allow time for the formal presentations. Begin questioning by the students.

6. After visitors have left, debrief the presentations by first asking specific questions about the context of the speakers' presentations. What were their special interests? What were the problems associated with that interest? Was a convincing factual case presented?

7. Next, focus on the process discussed by the speakers. How effective did the speakers think their methods were? How effective do you think their methods are? What made the presentations convincing or not convincing?

8. Finally, discuss the purpose and value of special-interest groups to American society. Typical questions might be:

- Do citizen groups represent the public interest any better than private industry does? Cite evidence to support your opinion.
- Is the decision-making process improved or impeded by input from a citizens' conservation group? Are quick decisions good or bad? Are slow decisions good or bad? What conditions determine whether a decision concerning the environment is good or bad?
- If these groups oppose a program or project, are they of value to society? If so, how? Cite evidence to support your opinion.

Evaluation:

A series of factual and process questions can be developed based on the speakers' presentations. You may also evaluate the questions students ask the speakers or have students write critiques of the presentations.

Extension/Enrichment:

Have students write thank you letters to the speakers explaining their own views of the various presentations.

30. A RESOURCE USE WARM-UP

Introduction:

The process of extracting resources from the earth creates a problem for people concerned about damage to the surrounding environment. This quick simulation can serve as an introduction to a unit on development and the environment by demonstrating, in a greatly simplified manner, the dilemma of competing values. It will be especially effective as an opener for a unit on resources and the environment.

Objectives: Students will be able to:

1. Explain why goals of resource extraction and environmental preservation conflict.

2. Appreciate the difficulty of resolving problems involving competing values.

Subject/Grade Level: World geography/grades 7, 10; U.S. history/grade 8; economics/grade 12; earth science/grade 8; environmental studies/grades 9-10

Time Required: 30 minutes

Materials and Preparation: You will need two chocolate chip cookies and five to seven toothpicks per student (plus a few extra cookies!).

Procedures:

1. Have students move into pairs. Distribute two cookies and several toothpicks to each pair.

2. Without specific instructions, tell students to remove the chocolate chips from the cookies. Allow a few minutes for students to work.

3. Stop students and ask them to examine the results of their work. What do the chips look like? What do the remains of the cookies look like? If the chips are the most important part, and you are going to chew them up anyway, will their appearance affect the way they taste? If the cookie is the most important part, and it is not to be consumed, but rather preserved, how does its present condition reflect that goal?

4. Students will likely protest that they were unaware of the goal of preserving the cookie. Inform them that they will have a second chance and that how well they do will determine whether the cookies will be eaten or thrown away! Students who extract the highest percentage of chips from their cookies will receive an extra cookie apiece as a reward. Have each pair of students discuss the methods they used to extract the chips the first time. How will they need to modify those efforts to preserve the cookies? What choices will they have to make? Will they be able to get all of the chips and still preserve the cookies? What is their ultimate goal? Is it worthwhile to them to leave some of the chir behind?

5. Allow a few minutes for discussion and planning. Then distribute two more cookies to each pair. Allow several minutes for this second round of "mining."

6. Stop the "mining" and have students discuss their efforts. How did the new goal affect their methods? Their results? Did anyone choose to ignore the cookies and try to get the most chips out so they could win the extra cookie? How successful were students, in terms of mining as many chips as possible? In terms of preserving the cookies? How did they use their "tools" this time compared to the first time?

7. Ask students what this activity simulates in the "real" world. (The conflict between mining resources economically and preserving the environment.) How similar were the choices students made to choices made in the "real" world?

8. Allow students to eat the remains of the cookies.

Evaluation:

No evaluation is necessary, although students may want to grade the cookies.

Extension/Enrichment:

Students might research the various ways in which resources are mined. Which are most destructive to the environment? Which are least destructive? Have students create a bulletin board display showing the results of their research.

31. THE OCEAN RESOURCES GAME

Introduction:

Nations' preoccupations with food, energy, natural resources, economic growth, environmental pollution, and military security all come together in their concern over the control and use of the world's oceans.

The basic laws of the sea were established in the 17th century and changed little until after World War II. Each nation had control of its coastal waters up to three miles from shore—the distance a cannon ball could be shot. Beyond that the seas were free for all.

Recent developments changed this. Improvements in military and commercial technology reopened the basic question—who owns the seas? Sophisticated fishing enterprises, aided by satellites tracking fish, overfished many regions—and raised controversies from Iceland to Peru. Depletion of the land's natural resources and the desire for independence from OPEC-controlled oil (Organization of Petroleum Exporting Countries) made tapping seabed oil and minerals economically and politically attractive. Pollution of the oceans—from wastes, military use, accidental and intentional oil dumping, and runoffs from land and river pollution—greatly increased. The control of the seas became, therefore, an urgent question for all nations—even those without direct access.

The United Nations has become involved in the process of resolving the complicated questions about control of the oceans. Important conferences were held in Venezuela, Switzerland, and New York in the 1970s, culminating in the signing of a Law of the Sea Treaty in Montego Bay, Jamaica in 1982. Although signed by 159 nations, this treaty has been ratified by only a few nations and has not gone into effect.

This lesson is a role-playing activity that provides an opportunity to explore the potentials for cooperation and conflict that have existed in relation to control of the seas. The situations the students encounter reflect some of the major issues at stake in the use of the world's seas. Through playing roles of decision-makers of various nations, students learn about issues and positions involved in exploiting the wealth of the sea, including minerals, oil, and fish.

Objectives: Students will be able to:

1. Identify some of the most important issues that must be resolved if all countries are to agree on a set of laws for the oceans and seas of this planet.

2. Identify the national interests of various countries, and make and defend proposals for laws of the sea that reflect the national interest of a particular county.

3. Compare interaction among groups (representing different countries) to the interaction among nations in the world today.

4. Discuss the importance of reaching agreement on a law of the sea and the difficulties of doing so.

Subject/Grade Level: World geography/grade 10; government/grade 12; current events/grades 10-12; earth science/grade 8; environmental studies/grades 9-10

Source: Adapted from *Intercom #107* (July 1985), pp. 10-11, 22-24. Reprinted by permission of the publisher, Global Perspectives in Education (A Program of The American Forum: Education in a Global Age, Inc.).

Time Required: 3-5 class periods

Materials and Preparation: Make copies of Handouts 31-1, 31-2, 31-3, and 31-4 for all students.

Procedures:

1. Distribute Handout 31-1. Allow 10 minutes for students to read the handout. Discuss the boldface terms and the general issues raised in the reading. Refer students to a world map to help them better visualize the examples described.

2. Distribute Handouts 31-2 and 31-3. Have the students read the profiles of all the countries around the Sea of Plenty and acquaint themselves with the map.

3. Divide the class into six groups and assign one country to each group.

4. Have the students meet within their "nation" to consider their objectives and how they intend to pursue these objectives in the coming international meeting.

5. Assemble the International Conference on the Sea (ICS). One student should act as chairman; the delegates determine their own rules for proceeding. Suggested procedure: Each nation speaks, one student from each nation acting as the spokesperson for his/her country. This may be the chief decision-maker or another member of the delegation.

6. Have the countries meet again to determine policies and strategies based upon what happened during the International Conference on the Sea.

7. Begin a negotiating period, during which countries may make bargains, agr ements, or alliances with other countries in preparation for the second round of the international confer..ce.

8. Have countries meet individually to develop their presentations for the next ICS meeting.

9. Hold the second meeting of the International Conference on the S .

10. Continue the cycle of national meetings, negotiations, and ICS meetings until either an agreement or an impasse has been reached.

11. The following questions may be useful in a debriefing discussion when the simulation has been completed:

- What happened in the game? Were all nations able to reach their goals? If agreement was reached, was it fair to all nations?
- How did the game compare with reality? What changes should be made to make it more realistic? What additional parties or pressure groups might be involved? How would their presence alter the outcome?
- Do students think the mileage limits should be uniform for all nations? Would that be fair?
- What will be the consequences for the world if agreement is not reached?

Evaluation:

Have students complete the following sentences:

- The most important issue to be resolved if all nations are to agree on a set of laws for the oceans is...
- The national interest of my country in the role play was...
- The best thing about the role play was...

- One thing I did not like about the role play was...

Extension/Enrichment:

1. Distribute Handout 31-4 to students and discuss the major points. How do these agreements compare to those reached by students during the simulation?

2. It would also be useful for students to examine the current Law of the Sea and discuss its major points. What problems have been solved? What problems still exist? How do the agreements reflected in the law compare to the agreements the students reached during the simulation?

Resources:

Annual Editions: Environment 84/85 (Guilford, CT: Dushkin Publishing Group, 1984).

Annual Editions: Global Issues 85/86 (Guilford, CT: Dushkin Publishing Group, 1985).

Development Data Book (Washington, DC: The World Bank, 1984).

Facts on File (New York: Facts on File, Inc., 1987). A weekly digest and index of news, compiled from major national and international newspapers.

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Hedley, Dan, *World Energy. The Facts and the Future* (New York: Facts on File, Inc., 1985).

McDonald, A., "Mines In a Lawless Sea," *The Geographical Magazine*, Volume 54(September 1982), pp. 501-503.

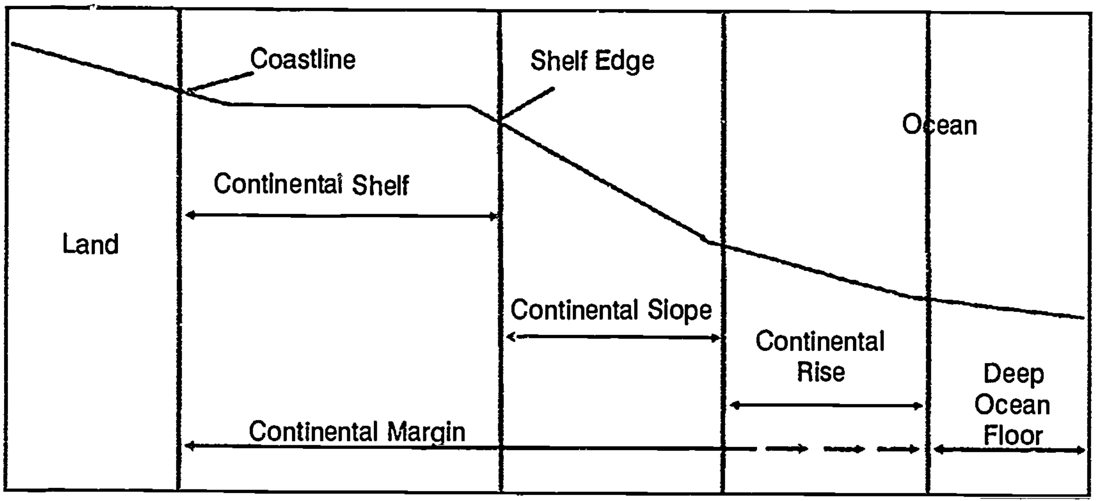
Taking Sides: Clashing Views on Controversial Environmental Issues, (Guilford, CT: Dushkin Publishing Group, 1984).

Wertenbaker, W., "A Reporter at Large (Law of the Sea Conference)," *The New Yorker* (August 1983), pp. 38ff.

POINTS OF CONFLICT: OCEAN RESOURCES

Familiarize yourself with the diagram of the *seabed* and the ocean floor and with the data that follows. Are all parts of the ocean equally valuable? Locate the areas where the different resources are concentrated. What are some of the potential conflicts?

Diagram of the Seabed and the Ocean Floor



Data

- The **continental shelf** may be as wide as 700 miles* off Siberia, Alaska, and Argentina, and as narrow as a few miles off Peru. The average width is about 40 miles.
- The **continental margins** may have as much as 40 percent of the world reserves of oil and gas.
- Most fish are taken within 50 miles off shore, and almost all within 200 miles. The ocean supplies 13 percent of the world's animal protein consumption, but fish catches have fallen drastically in recent years. Fishermen have successfully used sophisticated equipment to increase their catches. As a result, however, the remaining fish are insufficient in number to replenish the stock. Overfishing is believed to have contributed to the drop in the fish catch in many parts of the world.
- Lying on the sea floor, mostly beyond 200 miles off shore and the continental margins, are great quantities of **manganese nodules**. These hold a number of metals that are becoming increasingly scarce—primarily nickel (used in making stainless steel), and copper and cobalt. Harvesting these nodules from the sea may eventually be cheaper than mining them from land.

**Miles* in this handout refers to *nautical miles*. A nautical mile is 1.85 kilometers or 1.15 land miles. Nautical miles are the international standard for measuring distances at sea; for example, a ship's speed is measured in knots (nautical miles per hour).

- At least eight private and governmental groups have already made major investments to prepare to begin ocean mining. Involved are American, Canadian, French, West German, and Japanese concerns.
- With increasing shortages of food, oil, and minerals, countries are claiming more rights over the sea off their shores. A few nations, including Peru and Ecuador, claim **territorial jurisdiction** out to 200 miles of coastal seas. But other countries claim only **economic control** out to 200 miles. (This is an important difference. Economic control gives a nation the right to all the fish and mineral wealth within those limits. Territorial jurisdiction in effect extends the boundaries of a nation's property. All military, navigational, and economic rights on land would extend to this ocean territorial boundary. Economic rights would not cover military or navigational control.)
- If countries have territorial jurisdiction beyond three miles, there is a serious problem for the great naval powers, since there would be a threat to free transit through straits. If Spain were to have a 12-mile sea limit, for example, it could theoretically control the entrance to the Mediterranean Sea which, at Gibralter, is less than 10 miles wide. Under the long-standing principle of innocent passage, merchant ships can pass through straits even when they lie within the territorial jurisdiction of another nation. However, warships, submarines, and planes are not considered "innocent" and their passage could legally be blocked or restricted by the nation(s) with territorial jurisdiction over a strait. Thus, the great naval powers, such as the United States, are opposed to any extension of jurisdiction that could restrict the passage of their ships and planes through important straits.
- Some countries, like the Philippines and Indonesia, claim a 12-mile jurisdiction beyond the outermost islands of their archipelago grouping, thus enabling them to enclose huge areas of ocean within their territorial waters. Look at a map of the world—or a portion of the world such as Southeast Asia. If you shaded in a 200-mile territorial extension of each country, what situations would you see occurring?
- Many of the nations of the world believe the oceans are the common heritage of all people.
- Most of the poorest countries want an international agency to mine the mineral resources of the seabed and share the profits among nations. Burkina Fasa (previously called Upper Volta), Mali, Botswana, Chad, Afghanistan, and Nepal are among the poorest nations of the world. Look at a map. What do these countries have in common? How does lack of access impede the commerce and economic growth of these nations? How does this help explain their position?

COUNTRY PROFILES

The Sea of Plenty is becoming badly polluted. Some scientists predict that living resources (fish, etc.) are diminishing and that there will be almost no edible fish and shellfish within 25 years if present trends continue. An international conference has been called by nations surrounding the Sea of Plenty to consider adopting agreements for resolving their conflicting claims to territorial limits, rights of passage, exploitation of the deep sea beyond the continental shelves, etc.

Your objective, as representatives of these nations, is to work out fair agreements on the use of the ocean's resources. The basic issues you should consider are:

- What are the special concerns of your nation?
- With which nations are you most likely to experience conflicts of interest?
- How far should a nation's jurisdiction extend?
- Should there be a national economic zone beyond the territorial limit? If so, how far?
- Do nations have the right to pollute the oceans, whether off their own shores or on the high seas? If not, what should be done about it?
- Should the ocean be considered the common heritage of the people of the world? If so, should an international organization be formed to regulate the mining of the seas and use a percentage of the profits to foster the development of poorer nations?

Read the profiles of all the countries. Your teacher will then assign you to a group representing one of the nations.

Anchovia: Per capita Gross National Product (GNP) $1,000. Twelve-mile territorial limit. Now claims a 200-mile economic zone; that is, the right to all living and nonliving resources.

Insists on right of territorial control with Bushland over the Dire Straits. Concerned about oil spills from drilling around the Sea of Plenty and from the giant tankers from Oceana. The breakup of a smaller tanker caused millions of dollars damage to beaches and wild life. Fishing, especially of anchovies, is Anchovia's major industry—and the catch is diminishing each year. It is also concerned about the depletion of salmon, which spawn up the Salmon River. Oceana's trawlers take huge catches, often within Anchovia's 200-mile limit, which Oceana insists is legal. Anchovia demands a share of profits from exploitation of deep seabed mineral resources, and it also wants an international agency to license manganese nodule exploitation.

Bushland: Per capita GNP $200. Twelve-mile territorial limit. Two hundred-mile economic zone.

A poor, largely agricultural country. Fishing is a major source of protein for its ill-fed people. But the annual catch is declining, and this is blamed on Oceana's mass production fishing with advanced technology. Rich oil deposits have been discovered 125 miles off Bushland's southern coast. But these deposits are located on Petrolia's continental shelf. Petrolia is also drilling there for oil. Bushland wants a percentage of profits from manganese nodules, with their exploitation controlled by an international agency.

Outland: Per capita GNP $150. The country is landlocked.

Outland's people once controlled all of Petrolia and deeply resent not having any share in the great wealth coming to Petrolia from oil. Outland insists on a corridor to the sea and that all resources beyond a 12-mile limit belong to all mankind and should be placed under the jurisdiction of a worldwide organization.

Petrolia: Per capita GNP $4,500. Three-mile limit. Two hundred-mile economic zone.

Petrolia is an oil-rich country that is rapidly becoming a major industrial power. Its oil had previously been carried on Oceana's tankers, but now Petrolia is building its own naval fleet. It is insisting upon a three-mile territorial limit to insure free transit or noninterference from Bushland and Anchovia for Petrolian military vessels through the Dire Straits. Petrolia soon will have the technology to take manganese nodules from the deep seabed in the Sea of Plenty. It is therefore opposed to economic zones of 200 miles, which would prevent access to nodules within 200 miles off Anchovia, and it does not want interference from an international-controlling agency.

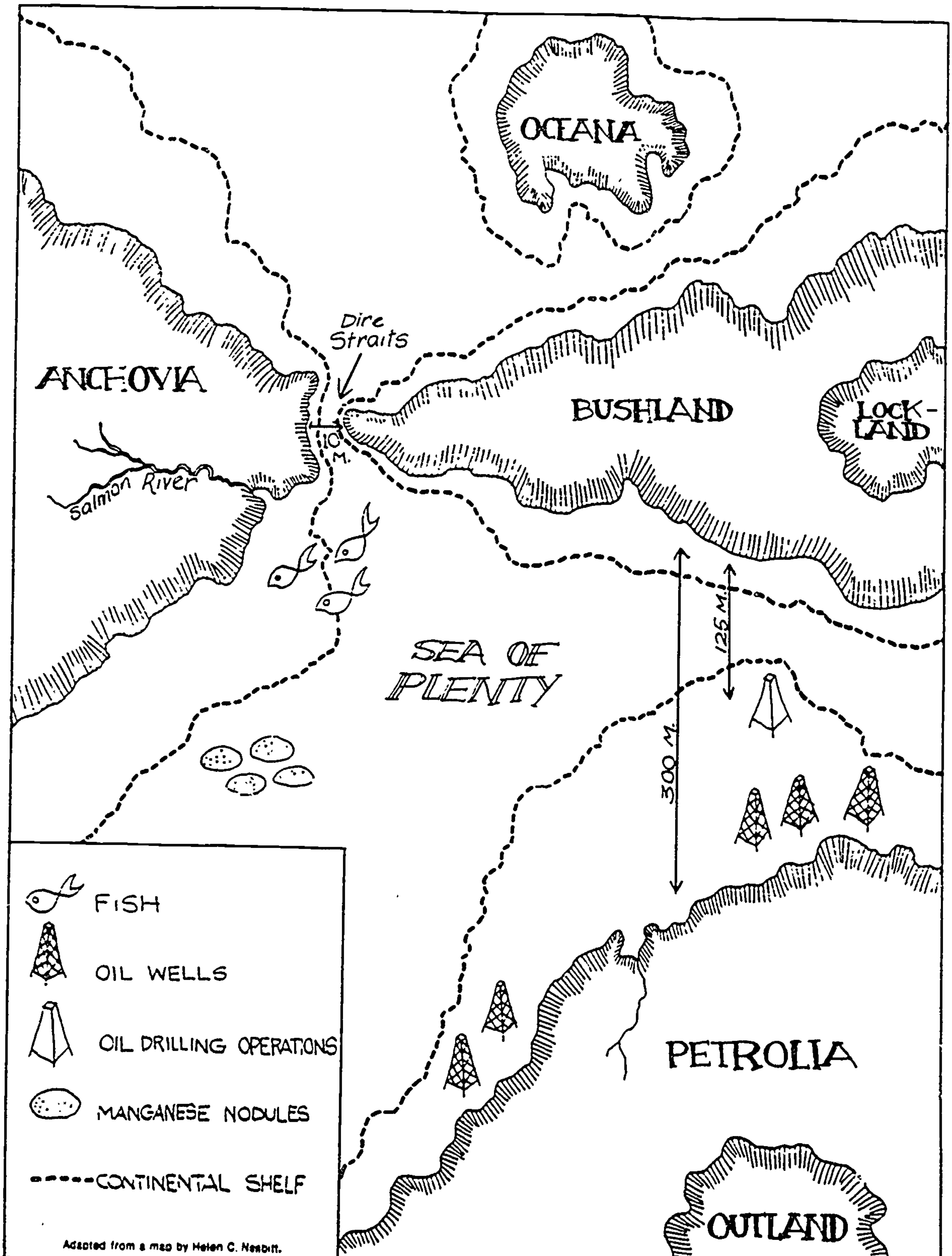
Oceana: Per capita GNP $5,000. Three-mile territorial limit. Twelve-mile fishing limit. Economic zone on continental shelf to depth of 200 meters.

Oceana is a highly developed industrial and military power. Its ships roam the world and fish with the most advanced technology in the Sea of Plenty, especially off Anchovia's Great Banks and Bushland's shores. Its giant tankers regularly bring vital oil from Petrolia through the Dire Straits to keep Oceana's industries rolling. It maintains a naval fleet, including nuclear submarines, in the Sea of Plenty. Free transit through the Dire Straits is essential for Oceana. It is already beginning to take manganese from the seabed at depths of two miles or more and opposes any effort to control its activities.

Lockland: Per capita GNP $100. The country is landlocked.

A poor country desperately attempting to find the capital for economic development, Lockland insists on establishing an international agency that will exploit all nonliving resources beyond the 12-mile limit, with the profits going to all nations. "Such resources are the common heritage of all mankind," declared Lockland's president.

MAP OF THE SEA OF PLENTY



Adapted from a map by Helen C. Nesbitt.

UNITED NATIONS LAW OF THE SEA CONFERENCE PROCEEDINGS

Basic Ideas of International Law

1. The oceans must remain open to all nations for the purposes of scientific study.

2. Any nation's activities must be conducted with due regard for the rights of other nations.

3. Any activity undertaken must be done in a way that maintains world peace and avoids adverse environmental effects.

Principles Governing the Seabed

On the basis of the work of the Seabed Committee, the General Assembly in 1970 adopted unanimously the Declaration Principles governing the seabed and ocean floor. Some of the major points are summarized below.

1. The seabed and ocean floor, and the subsoil thereof, beyond the limits of national jurisdiction, as well as the resources of the area, are the common heritage of mankind; the area is not subject to appropriation and no state may claim or exercise sovereignty or sovereign rights over any part thereof; no state or person shall claim, exercise or acquire rights with respect to the area or its resources incompatible with the international regime to be established and the principle of the declaration.

2. The area is open to use exclusively for peaceful purposes.

3. The exploration of the area and exploitation of its resources are to be carried out for the benefit of mankind as a whole; any nation's activities must be conducted with regard for the rights of other nations.

4. States shall act in the area in accordance with the applicable principles and rules of international law, including the UN Charter, and in the interests of maintaining international peace and promoting international cooperation and mutual understanding.

5. Any activity undertaken must be conducted in a way that avoids environmental damage.

It is the first time in history that the concept of common heritage has found expression in an international instrument. It is perhaps even more significant that an area of at least 225 million square kilometers is reserved for mankind as a whole and will be administered by an international organization on its behalf.

32. GOD AND THE ALARM CLOCK

Introduction:

This lesson introduces value conflicts between societies. The scientific and technological advances that powered European imperialism were often used to lure subject peoples into Western religions. Not all colonial peoples accepted the illegitimate association of technology and religious truth. One such man was Prince Modupe, born in Guinea but later a resident of the United States. This lesson centers around an excerpt from his book, *I Was a Savage*, a description of his boyhood.

Objectives: Students will be able to:

1. Explain how Western missionaries used technology to "sell" their religion.

2. Analyze source material.

3. Respect the values of other cultures.

Subject/Grade Level: World history/grade 10

Time Required: 1 class period

Materials and Preparation: Make copies of Handout 32-1. This activity could be controversial; if you have concerns about its use, check with your department chair or principal.

Procedures:

1. Ask students to speculate on whether there is any connection between religion and technology. Review information about Western colonization of Africa, Asia, Latin America, and Australia.

2. Distribute Handout 32-1. Inform students that they are to look for sentences that illustrate differences in values between the whites and the Africans. Allow time for student reading.

3. Discuss the following questions:

- How did whites connect material technology and spiritual beliefs? What were their goals? What was the usual African reaction to that position?
- Out of all of the technological artifacts he must have seen, why did Modupe choose the alarm clock as his main example? What was the analogous African technology? Is one technology inherently "better" than the other? Why? What cultural values are expressed in the two different technologies for measuring time?
- What does Modupe think about the missionaries' misuse of technology to gain converts?
- How do you think his discovery affected his attitude toward technology? Toward Christianity? Cite evidence in the reading to support your position.

4. To close the activity, write on the board: "Conflicts of values and technologies of different cultures are..." Have students complete the thought by writing a short paragraph.

Evaluation:

Collect students' paragraphs (see step 4 in **Procedures**) for evaluation purposes.

Extension/Enrichment:

Encourage students to do additional reading on religion and technology. How have religious organizations used technology—to gain converts and to get their message across?

GOD AND THE ALARM CLOCK

Christian missionaries often used Western technology to get Africans to join the church. Some Africans recognized the dishonesty of associating the two. One such man was Prince Modupe. The following selection was taken from a book written by Prince Modupe.

One day I was reading along in First Corinthians when none of the words seemed to make much sense or to be of special interest. The day was drowsily, dreamily hot. A fly buzzed around my head, distracting me. I was about to give up when a certain few words popped up at me as though they had been in larger print, in bolder ink. They seemed to have no connection in meaning to any of the words before or after them

"*There is one glory in the sun, and another glory in the moon, and another glory of the stars....*"

I stopped reading, I repeated the words over aloud to myself. Into my mind flashed the sight of my grandfather bending thoughtfully over the sundial he made by crisscrossing straws over a gourd. I saw him in my imagination as clearly as though my feet were in Dubricka. I saw every line in his good, kindly, noble face. I knew that he never looked at his homemade time device without feeling in his venerable bones the glory of the sun, that other glory of the moon, that further glory of the stars. He often spoke to me about these things. He meditated upon them.

A chill of excitement ran through me. I shivered with it as though in a fever chill, in spite of the heat of the day. I had found my first clear answer to the confusions that deviled me! THE GLORY OF GOD WAS NOT IN AN ALARM CLOCK! THE GLORY OF GOD WAS IN THE SUN AND THE MOON AND THE STARS! The Bible had carried God's mouth to me on that and I knew it for truth.

Perhaps I could have arrived at this sooner and with less mental anguish had not that first white man who came to Dubricka showed us mechanical gadgets as evidence of the power of God. Only one article in his "juju kit" was of spiritual import—the Bible. Every other thing with which he tried to impress and convert our people was not an artifact of his religion, but a representative item from his machine civilization. He had led us to believe that white nations had guns and steamships and skyscrapers and mirrors and matches, while the black tribes had none of these things, because the white God was more powerful. White men had accredited their own brilliant inventions to their God in an attempt to enhance God's power. As though God needed an alarm clock to be great! The greatness of God was in every stick and stone and star, just as we had been taught in the Bondo Bush. If God had a face, which seemed more improbable than ever now, that face bore more resemblance to my grandfather's when he felt the sun blessing his old bones than it did to the crafty visage of a spying policeman.

Source: Excerpted from *I Was a Savage*, by Prince Modupe (New York. Harcourt, Brace, Jovanovich, 1957). Copyright by Harcourt, Brace, Jovanovich. Reprinted by permission of the publisher.

33. A SOCIAL HISTORY APPROACH: MACHINE AND SOCIAL CHANGE IN INDUSTRIAL AMERICA

Introduction:

Industrialization in 19th-century America was a development in social as well as economic history. Whole patterns of social interaction, attitudes, and values concerning work were being altered by the new industrial system. This moderately structured inquiry-based role-play explores some of these dimensions of social change. The lesson bridges two traditional content areas: industrialization in the North and emergence of a business- and industrial-oriented New South following the Civil War.

Objectives: Students will be able to:

1. Describe changes in work styles and social relationships brought about by industrialization.
2. Gather and analyze data to develop roles.
3. Empathize with people who experienced the effects of industrialization.

Subject/Grade Level: U.S. history/grade 11; economics/grade 12; sociology/grade 12

Time Required: 4-5 class periods

Materials and Preparation: To provide students with sufficient sources of information for the development of realistic role identities, you will need to schedule a day of library research or bring a variety of sources on the post-Civil War South into the classroom. You will also need to make a copy of the Document Packet for each student.

Procedure:

1. Tell the class that each student will be developing an identity of a 19th-century American who has both a reasoned point of view about the social benefits and disadvantages of industrialization and feelings and sensitivities that will be affected by the changes involved. Their work will be evaluated on the basis of how fully and persuasively this identity is developed.

2. Introduce the historical situation that will be simulated by discussing the economic condition of the post-Civil War South—its predominantly rural, agrarian economy and its reliance either upon local, handicraft producers or upon imports from the more industrialized North for manufactured tools. During the course of this discussion, hand out Henry Grady's statement (Document One) about the industrial backwardness of the South. It illustrates the major point to be made here.

3. After the statement by Grady has been discussed, introduce the role-playing situation by explaining that, for the next several days, the class is to imagine that it is meeting in the committee room of a Southern state legislature's Committee on Manufactures. The task of the committee is to consider legislation it might recommend to encourage or discourage manufacturing in the state. That it might want to discourage industrial growth may seem incongruous after the discussion of the Grady quote. Raise the question whether Grady's position would have been a reasonable alternative, considering some of the social consequences of industrialization. In what respects would industrialization not be beneficial? How would the growth of manufacturing affect Southern society? To what extent would a person's role and place in society influence his/her attitude toward industrial development?

Source: Adapted from *Teaching American History. Structured Inquiry Approaches*, Glen M. Linden and Matthew T. Downey (Boulder, CO: Social Science Education Consortium, 1975).

4. Ask the students to choose the roles they will assume for the duration of the lesson. Five students should act as members of the Committee on Manufactures and should decide what kind of constituency each is representing as a legislator. They should play the roles of such legislators. They should choose one student as chair of the committee to preside over the meetings. The teacher should remain silent, if possible, and do systematic observation in preparation for the debriefing exercise. The remainder of the class can develop identities either as (1) Northern men, women, or children who are appearing before the committee as expert witnesses or (2) Southern people who have not yet been greatly affected by economic change but who are anticipating it. With the assistance of the students, the teacher should develop a list of possible roles and write it on the board. Some possibilities would be:

Unskilled laborers

cotton field hand
dock worker
housekeeper

Semi-skilled workers

machinist
textile mill worker
other factory workers

Skilled workers

blacksmith
shoe maker
tailor
harness maker
carpenter

Professionals

lawyer
teacher
doctor
clergyman

Business

banker
storeowner
machine shop owner
small manufacturer

Agricultural

farmer
sharecropper

5. At the beginning of the second period, which is a preparation period, the teacher should make available the rest of the Document Packet. These are to be considered the written testimony of witnesses who were unable to attend the committee hearing in person. While the hearing is in progress, the five committee members should distribute these materials and initiate a discussion of them. This provides an opportunity for the class to consider the views of some 19th-century Americans and to clarify the roles they themselves are assuming. The point should not be missed that the social consequences of industrialization were viewed differently depending upon the person's social position, role, and perspective.

6. After a day of preparation, the committee should hear testimony of the witnesses present in the classroom. Those students who wish to report orally from the perspective of the role they are playing should do so. The other students will be considered interested spectators, who will submit their reports later in written form.

7. At the end of the testimony, the five-member committee will decide upon its course of action. To focus their discussion, the teacher can list on the board some possible alternatives and solicit others from the class. For example, the Committee on Manufactures might recommend to the legislature that it:

- Provide a state subsidy to manufacturing companies choosing to locate in the state.
- Launch a "sell the state" campaign, advertising the advantages to companies locating there.
- Enact legislation regulating working conditions.
- Try to discourage manufacturing by placing heavy taxation on industrial property.

- Prohibit manufacturing establishments that employ more than ten persons.

Each committee member will explain the policy he/she prefers, given how he/she perceives the social consequences of his action for his/her constituents. Finally, the committee will vote upon one or more recommendations.

8. It is essential that some time be spent debriefing the role-playing exercise. The students will need to assess the action of the committee members of the previous day. This could lead to a discussion of the importance of political decision making within the process of economic and social change. This will also give the class the opportunity to arrive at some conclusions about the social consequences of industrialization. They should be encouraged to consider the consequences it has had for present-day society and the effect of technological change and economic growth on their own lives. Finally, the teacher may profitably direct the discussion toward the students' values and attitudes regarding social change.

Evaluation:

The students should be evaluated on the basis of how fully and persuasively they have developed their role identities. While imagination will necessarily play a part in this, the roles must also be historically faithful. The students have the option of presenting their role identifies either through an oral presentation during the legislative committee's hearings or as a written report. Each of the five committee members should be evaluated primarily upon his or her justification for the policy alternative he or she selects on the fifth day of the lesson.

Extension/Enrichment:

Point out that some of the issues related to industrialization are similar to arguments about economic development today. Some states and communities have attempted to limit development in order to protect the environment, while others have felt it necessary to actively seek development in order to gain employment for citizens. Have students research your own state or community's position on development and determine whether they agree or disagree with its position.

DATA PACKET

Document One

Name: Henry Grady

Occupation: Editor, Atlanta *Constitution*, and spokesman for an industrial future for the South

Date: 1889

"A few years ago I told, in a speech, of a burial in Pickens County, Georgia. The grave was dug through solid marble, but the marble headstone came from Vermont. It was in a pine wilderness, but the pine coffin came from Cincinnati. An iron mountain overshadowed it, but the coffin nails and screws and the shovels came from Pittsburgh. With hard woods and metals abounding, the corpse was hauled on a wagon from South Bend, Indiana. A hickory grove grew nearby, but the pick and shovel handles came from New York. The cotton shirt on the dead man came from Cincinnati, the coat and breaches from Chicago, the shoes from Boston; the folded hands were encased in white gloves from New York, and round the poor neck, that had worn all its living days the bondage of lost opportunity, was twisted a cheap cravat from Philadelphia. That country, so rich in undeveloped resources, furnished nothing for the funeral except the corpse and the hole in the ground and would probably have imported both of those if it could have done so."

Source: Excerpted from *The New South: Writings and Speeches of Henry Grady*, by Mills Lane, ed. (Savannah, GA: Beehive Press, 1971), pp. 121-22. Reprinted by permission of the publisher.

Document Two

Name: Robert S. Howard

Occupation: Textile worker, secretary of local labor union

Date: 1883

"It is a constant race from morning to night after this machinery; and you may know as well as I can tell you, how a man must feel in this hot weather following such an occupation as that. He just feels no manhood about him. He can only take a glass of beer to stimulate him, to give him a little appetite so that he may eat, in order to be able to go through his daily drudgery. I have been there and I know it. From the time I was very young I was fond of reading, and I remember many occasions when I have gone to my supper and taken my daily paper and have fallen asleep with the paper in my hand, and have slept there until about eleven o'clock. Then I have been determined to read it, and have put my lamp beside me when I went to bed, and have gone to sleep again with the paper in my hand and lain there just as I put myself down, without stirring, until morning, the result of exhaustion.

"Now we can never expect advanced civilization among such a class of people until we get a reform of this miserable condition of affairs."

Source: Excerpted from *Labor and Capital in the Gilded Age*, John A. Garraty, ed. (Boston, MA. Little, Brown, 1968), p. 25.

Document Three

Name: Samuel Gompers

Occupation: Skilled craftsman (cigar maker), labor organizer, and soon to be first president of the American Federation of Labor

Date: 1883

"Yes, sir. They find that employers are no longer—when I speak of employers I speak of them generally—that they are no longer upon the same footing with them that they were on formerly. They find that where a man who may have worked at the bench with them employs one or two hands they and he may have full social intercourse together, but as that man increases his business and employs a larger number of hands they find that his position has been removed so far above that of his old friends that they meet no more socially. Probably they may meet occasionally in the factory, when there will be a passing remark of 'Good morning' or 'Good day'; and then, after a while, the employer fails to see the employees at all; the superintendent does all the business and the employer does not bother himself any more about the men. That is how the position of the two has been changed since both were workingmen at the bench. The difference is considerably greater when the employer and the employee did not know each other before.... In most such instances the employees are not known as men at all but are known by numbers—'1', '2', '3', '4', and so on..."

Source: Excerpted from *Labor and Capital in the Gilded Age*, John A. Garraty, ed. (Boston, MA: Little, Brown, 1968), p. 18.

Document Four

Name: R. Heber Newton

Occupation: Episcopal clergyman and social reformer

Date: 1883

"The whole condition of industrial labor has changed in our century. Contrast the state of such labor a century ago with what it is now. Then the handicraftsman worked in his own home, surrounded by his family, upon a task, all the processes of which he had mastered, giving him thus a sense of interest and pride in the work being well and thoroughly done. Now he leaves his home early and returns to it late, working during the day in a huge factory with several hundred other men. The subdivision of labor gives him now only a bit of the whole process to do, where the work is still done by hand, whether it be the making of a shoe or of a piano. He cannot be master of a craft, but only master of a fragment of the craft. He cannot have the pleasure or pride of the old-time workingmen, for he *makes* nothing. He sees no complete product of his skill growing into finished shape in his hands. What zest can there be in this bit of manhood? Steam machinery is slowly taking out of his hands even this fragment of intelligent work, and he is set at feeding and watching the great machine which has been endowed with the brains that once was in the human toiler."

Source: Excerpted from *Labor and Capital in the Gilded Age*, John A. Garraty, ed. (Boston, MA: Little, Brown, 1968), p. 37.

Document Five

Name: Carroll D. Wright

Occupation: Head of Massachusetts Bureau of Labor Statistics

Date: 1883

"I am thoroughly satisfied that the factory has been a wonderful element in our civilization towards its advancement.... I know the feeling is that the factory system has more and more tended to degrade labor, because under that system thirty or forty years ago, as established in New England, we employed only American girls from our farm houses, while now we see an entirely different class in our factories; but I fail to find that the class who used to be in factories have gone down; they have stepped up into school teaching, telegraphy, and the higher branches of labor, while their places have been filled by a class that have come up from a lower occupation.... By the factory we are constantly opening wider the field of advancement for that class of people who unfortunately stand on the lower round of the industrial ladder—we are bringing them up closer."

Source: Excerpted from *Popular Culture and Industrialism, 1865-1890*, Henry Nash Smith, ed. (New York: Anchor, 1967), pp. 52-53. Reprinted by permission of Doubleday.

Document Six

Name: Robert H. Thurston

Occupation: Mechanical engineer

Date: 1880

"Looking back upon our past history, we have seen the growth of our cotton manufactures, from the small beginning of Samuel Slater, and his humble rivals in a New England village, grow, until today many mills of forty thousand spindles each have been built, and the hum of their machinery and the clatter of their shuttles make music in the ears of two hundred thousand thrifty and happy working people. From absolute dependence upon Great Britain, we have grown to independence, and now, more than ten millions of spindles, and nearly a quarter of a million looms in our thousand mills supply Canada, South America, and even China annually with millions of dollars worth of goods.

"Our associates have made this country the most prosperous and happy in the world."

Source: Excerpted from *Popular Culture and Industrialism, 1865-1890*, Henry Nash Smith, ed. (New York: Anchor, 1967), pp. 27. Reprinted by permission of Doubleday.

Document Seven

Name: John Morrison

Occupation: Machinist in New York City machine shop

Date: 1883

"When I first went to learn the trade a machinist considered himself more than the average workingman; in fact he did not like to be called a workingman. He liked to be called a mechanic. Today he recognizes the fact that he is simply a laborer the same as the others. Ten years ago even he considered himself a little above the average workingman; he thought himself a mechanic, and felt he belonged in the middle class; but today he recognizes the fact that he is simply the same as any other ordinary laborer, no more and no less...."

Questioner:

"I am requesting to ask you this question: Dividing the public, as is commonly done, into upper, middle, and lower classes, to which class would you assign the average workingman of your trade at the time when you entered it, and to which class you would assign him now?"

Morrison:

"I now assign them to the lower class. At the time I entered the trade I should assign them as merely hanging on to the middle class; ready to drop out at any time."

Source. Excerpted from *Popular Culture and Industrialism, 1865-1890*, Henry Nash Smith, ed. (New York: Anchor, 1967), pp. 276-77. Reprinted by permission of Doubleday.

34. TECHNOLOGY AND TRANSPORTATION

Introduction:

A timeline can show not only the change that has occurred over a certain time period but the remarkable nature of the change. In this lesson, students look at a timeline showing various forms of transportation, analyzing the changes that have occurred. They also evaluate the technological achievement that has taken humans from transportation on foot to transportation beyond our earth's atmosphere.

Objectives: Students will be able to:

1. Describe how transportation has changed over time and the effects these changes have had on society.

2. Understand that technological advances have both positive and negative effects.

3. Interpret a timeline.

4. Appreciate advancements made in transportation.

Time Required: 1 class period

Subject/Grade Level: U.S. history/grades 8, 11; economics/grade 12; sociology/grade 12; general science/grade 9; physical science/grades 8-9

Materials and Preparation: Make copies of Handout 34-1 for all students. You may want to review each of the time periods presented on the timeline so you can provide historical information to students.

Procedures:

1. Tell students that technological developments have changed the way we live, our leisure time, where and how we work, and many other aspects of daily life. Ask students to brainstorm a list of technological developments that have improved their lives. This list should be lengthy, including such things as new fabrics, advances in food technology, medical advances, forms of transportation, ways in which we communicate, and so on.

2. Tell students that in this activity they will look at how technology has changed transportation. Do not use the word improve, because some people might disagree that present forms of transportation are improvements over older forms.

3. Distribute copies of Handout 34-1. After briefly reviewing the timeline, allow students 10 or 15 minutes to complete the individual questions. The group questions should not be answered at this time.

4. When students have completed the individual questions, divide the class into groups. Ask each group to review the answers to the individual worksheet questions. Before group members go on to the group worksheet questions, each group should spend some time discussing questions 2 and 3. Encourage groups to try to reach consensus on these questions.

5. Then have groups finish the worksheet, with each student writing in the group responses to the remaining questions as they are discussed. A group spokesperson should be appointed to report to the class on the result of group discussion. If time permits, you might encourage groups to illustrate the changes they identify.

6. After groups have had an opportunity to work through the remainder of the questions, ask each group spokesperson to report on the group's discussion.

7. Conclude the activity by leading a discussion of the following questions:

- Did individuals and groups select different answers for questions 2 and 3? Ask for a show of hands to determine how many students selected a different form of transportation for questions 2 and 3.
- How has technology changed transportation during the past 150 years?
- How has each of the following forms of transportation changed lifestyles during the past 4,000 years?

  a. Horse
  b. Wheel
  c. Boat
  d. Train
  e. Car
  f. Airplane
  g. Space vehicles

- How has transportation technology changed your own lifestyle?

Evaluation:

You may collect the worksheets for evaluation purposes. You might also ask students to write a paragraph in response to the second and third questions in step 7 of the Procedures.

Extension/Enrichment:

Have students develop timelines showing technological developments in other areas that have had great societal impact; examples might include farm equipment and household appliances.

Resources:

Charles Singer, E. J. Holmyard, A. R. Hall, and Trevor I. Williams, editors, *A History of Technology, Volumes I to V* (London: Oxford University Press, 1958).

TRANSPORTATION TIMELINE

Study the timeline on the next page. Then answer questions 1 through 3.

1. Describe how technology has changed transportation.

2. When have the greatest changes in transportation technology taken place? Why do you think this is true?

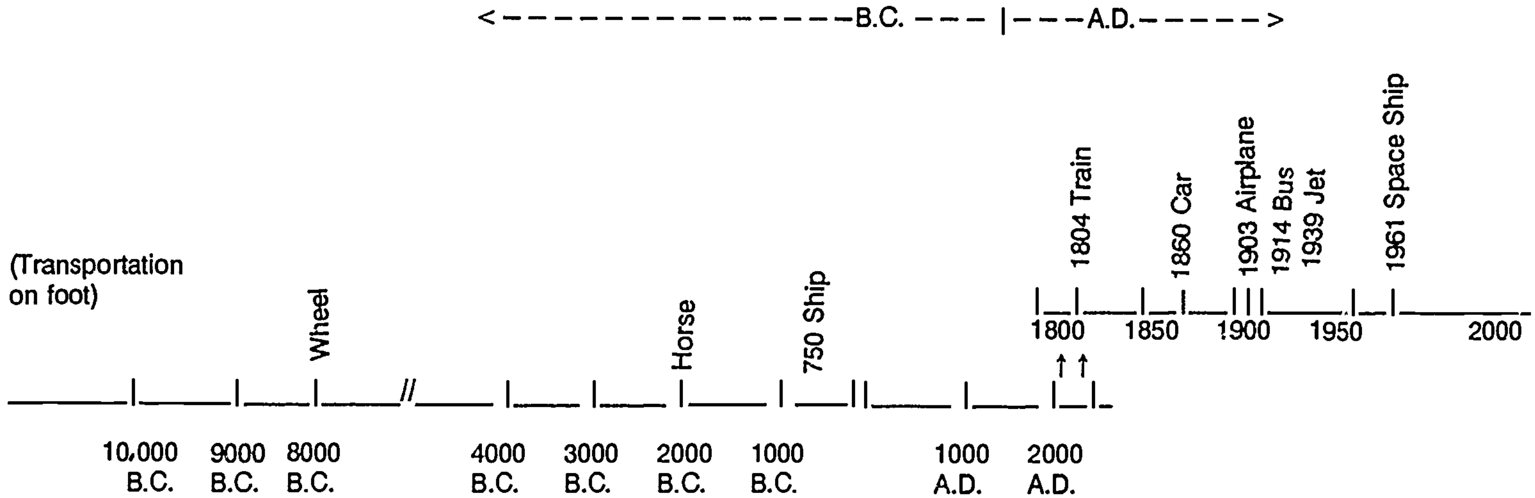
3. Which transportation technology do you think has had the greatest impact on society? Explain your answer.

With a group of classmates, discuss the following question.

4. List ways in which each form of transportation has affected the economy, the environment, and society (how people live together).

	Economy	Environment	Society
A. Foot			
B. Wheel			
C. Horse			
D. Ship			
E. Train			
F. Car			
G. Bus			
H. Airplane			
I. Jet			
J. Space Travel			

ADVANCES IN TRANSPORTATION TECHNOLOGY



35. SCIENCE, TECHNOLOGY, AND THE CONSTITUTION

Introduction:

Many Americans take the accomplishments of science as much for granted as they do the freedoms protected by our Constitution. They do not recognize the degree to which constitutional law has provided the economic incentive and intellectual freedom for science to flourish. Nor do they realize that science, technology, and society are becoming increasingly interdependent. These ideas are the focus of this lesson.

Objectives: Students will be able to:

1. Define *science* and *technology* from their own personal perspectives.

2. Describe the relationships among science, technology, and our democratic society.

4. Analyze a primary source document.

4. Appreciate the protections the Constitution gives to creative efforts, including science and technology.

Subject/Grade Level: U.S. history/grades 8, 11; civics/grade 9; government/grade 12

Time Required: 2 to 3 class periods

Materials and Preparation: Read the Teacher Background Information. Obtain one copy of the Constitution and cut it into as many pieces as there are students. You will also need poster paper and markers.

Procedures:

1. Write these focus questions on the board: "What is science?" "What is technology?"

2. Tell students that you want them to respond to the questions by making a mural to represent their definitions of science and technology. Assign students to teams.

3. Ask each team to brainstorm a list of ideas they would like to represent in their art project. Each team should decide the best way to divide the work. While they are planning, distribute markers or crayons and poster paper to each team.

4. Once the teams have completed their artwork, have them post their murals.

5. Using only the murals as a resource, have each student write separate definitions for the words *science* and *technology*.

6. After students have completed individual definitions, have each team introduce its mural and explain the ideas represented. Encourage questions and discussion from other students in the class.

7. During the explanations and discussion, record students' ideas on the board under the focus questions: "What is science?" "What is technology?"

Source: Adapted from *National Science and Technology Week '87 Activity Guide* (Colorado Springs, CO: Biological Sciences Curriculum Study, 1987). Used by permission of the publisher.

8. Have the class analyze each list looking for generalizations about science and technology. After a teacher-guided discussion of these ideas, have students develop class-approved definitions of *science* and *technology*. Write these on the board.

9. Tell the class that science includes attitudes and processes as well as knowledge. With the students, group similar ideas that appear under each focus question. Consult **Teacher Background Information** for lists of characteristics. (Visual aids, such as circling similar ideas with colored chalk, may be helpful.)

10. Using the murals, list of ideas, and definitions of science and technology, have students generate a list of the characteristics of science, including attitudes and processes or methods. Use the lists of characteristics in **Teacher Background Information** to facilitate this discussion. If necessary, write these characteristics on the board. As the students discuss characteristics of science and technology, have them record these in their notebooks.

11. After students complete the lists of characteristics, ask whether they need to revise their class definitions of *science* and *technology*. If so, how? Adjust the definitions if necessary.

12. Ask the students whether they think science and technology have been important in the development of the United States. If so, how? Ask the students what they think our Constitution says about science.

13. Distribute small sections of the U.S. Constitution to each student in the class. Ask each student to read his or her section to find out if it says anything about science.

14. Ask those students who have a section that makes a reference to science to stand on one side of the room and those who have sections that have no reference to science to stand on the other side of the room. (Since the word, *science*, appears only once in Article I, Section 8, it is likely that only one student will be standing on the "science" side of the room.)

15. Have the student who has located the reference to science in the Constitution read his or her section. (The section from Article I, Section 8, reads: "To promote the Progress of Science and useful Arts by securing for limited Times to Authors and Inventors the exclusive right to their respective Writings and Discoveries.")

16. Tell your students that this reference to science is the foundation for the Patents Act of 1790. Discuss how patents ensure security for scientists and inventors.

17. Pair the students and have them re-read their sections of the Constitution to locate provisions more subtly related to science and technology.

18. List all science-related provisions on the board. Discuss why these provisions are considered to be related to science and technology.

Provision	**Location**
Patents	Article I, Section 8
Freedom of speech, or of the press	Amendment I
Provide for the common defense	Preamble
Promote the general welfare	Preamble
Census	Article I, Section 2
Standard of weights and measures	Article I, Section 8

19. Ask teams to decide which of the six science-related provisions promoted the independence and support of science. Teams should justify their answers.

- Freedom of speech and the press were essential for free exchange of scientific ideas and discoveries.
- Financial freedom was furnished to inventors and authors by the development of the patent system.

20. Have the class consider the four remaining provisions. Ask how science and technology supported the new system of government through each of these provisions. Have teams discuss these ideas prior to class discussion.

- "We the People of the United States" emphasizes that the people are the source of authority for the Constitution of the U.S. This authority was reinforced by a quantitative procedure, that of a regular census.
- Science and technology have supported the freedom of the United States by research and development in "providing for the common defense."
- Science and technology have led to new advances in biomedical and physical science, thus "promoting the general welfare" of the people of the United States.
- The establishment of standards of weights and measures assured common units of measurement. This standard developed accuracy and provided a basis for ready comparison of experimental data.

Evaluation:

Conduct a scored discussion on government and science. These types of questions might be included: Should scientists and engineers decide how technology should be used? Should the government tell scientists what problems to research? Should the government tell scientists how to do their work or what the "right" answers should be? Do citizens have enough education about science and technology to make good decisions about science- and technology-related social issues? Do members of Congress and judges know enough about science and technology to make good decisions about science- and technology-related social issues?

Extension/Enrichment:

1. Have students draw portraits of scientists that illustrate the characteristics of science. For example, the scientist's head could be open to illustrate an open mind.

2. Take a poll of certain groups (adults in the community, students, siblings, teachers) to find out how much they know about science, technology, and government.

3. Invite a scientist for a class visit/interview. Students should plan their questions in advance. Some possibilities include: What is your work like (What do you do, how do you do it)? How do you overcome personal biases about your work? How do scientists develop a positive attitude toward making mistakes? If you were to make a new discovery, what would you do with your findings? Who would hold the patent? Can you patent both products and ideas? Can you describe a scientific problem you have solved? What can government, business, and the public do to further scientific investigation? Who supports your research? What do you find most rewarding about your work? most frustrating? What are the rights and responsibilities of scientists?

4. Have students interview science teachers about the importance of intellectual freedom and free speech in teaching.

Resources:

Barbour, Ian G., *Technology, Environment, and Human Values* (New York: Praeger, 1980).

Education Policy Commissions *Education and the Spirit of Science* (Washington, DC: National Education Association, 1962).

Hurd, Paul D., "The Nature of Science," *New Directions in Teaching Secondary School Science* (Chicago: Rand McNally, 1969).

Liberty and Learning in the Schools: Higher Education Concerns (Washington, DC: The American Association of University Professors, 1986).

Price, Don K., "Science, Technology, and the Constitution," *National Forum* (Fall 1984), pp. 53-56.

Smith, Walter S., et al., *COMETS Science* (Washington, DC: National Science Teachers Association, 1984).

Teacher Background Information:

Science is a way of knowing and learning about the world. In their work, scientists use a variety of process skills including observing, classifying, hypothesizing, problem solving, critical thinking, and creative thinking. Science is also a way of organizing what is known about the world. The theories and concepts that comprise the scientific disciplines are examples of this organization.

When scientific knowledge is applied, the result is called technology. Technology uses knowledge to change the environment in ways that serve human needs. Technology is the practical application of knowledge, usually to fulfill basic human needs or to improve the quality of life.

The intellectual activities related to science and technology are complex, so neither science nor technology can be defined simply. Science is more an outcome of a person's thinking than it is a prescribed research procedure. Technology results from objective, scientific thinking but is heavily dependent on social and cultural values. Technology was the instrument for "taming the wilderness" of America as well as the source of material progress and human fulfillment. Due to the complex nature of both science and technology, the nature of these terms is better captured by a list of characteristics than by conventional definitions.

Some characteristics of science include:

- Seeking to know and to understand.
- Questioning all things.
- Collecting data and searching for their meaning.
- Demanding proof.
- Respecting logic.
- Considering previous knowledge.
- Suspending final judgment.

Some of the characteristics useful for describing technology include:

- Using knowledge to change the environment.
- Serving human needs.
- Applying knowledge practically.
- Proposing to improve the quality of life, knowing that there are attendant risks and benefits.
- Increasing the opportunity for choice.
- Increasing leisure.
- Improving communication.

- Creating uniformity.
- Improving efficiency.
- Increasing impersonality.
- Creating a feeling of uncontrollability (the individual is powerless).

Though brief, this discussion should provide an introduction to the nature of science; that is, what science is about and how it functions. Let us now look at some aspects of the Constitution that relate to the scientific enterprise.

The Constitution of the United States is important to the scientist because it limits governmental powers that restricted scientists at earlier points in history. With the founding of our government, scientific and political ideas were joined for the first time in history. The founders of our country rebelled against the arbitrary power of a monarchy, in favor of the "Laws of Nature and Nature's God." Two prominent scientists and statesmen, Benjamin Franklin and Thomas Jefferson, are recognized for contributing to the conceptualization of government based on ideas that were underlined by concepts from the Newtonian synthesis. In the world view of 1787 what was good for science was good for society.

The Constitution of the United States actually says very little about science. The word "science" appears only once in the document. Article I, Section 8 provided for scientists to patent their work and profit from their ideas. Other references to the work of scientists include the need for taking a census, or scientific count of the population (in Article I, Section 2, and again referred to for purposes of taxation in Article I, Section 9). Important but indirect references are made to science in other parts of the document. The Preamble to the Constitution mentions two purposes for forming the government that relate directly to science: "providing for the common defense" and "promoting the general welfare." Perhaps the most important provision is the First Amendment. That amendment ensures the scientific community, as citizens, the independence needed for the free exchange of ideas by prohibiting any law "abridging freedom of speech or the press...or the right to petition the government for a redress of grievances."

36. THE STRUCTURE OF SCIENTIFIC REVOLUTIONS

Introduction:

Scientific change, like political change, proceeds in revolutionary leaps, as well as incremental steps. This lecture-based lesson examines the process of scientific revolutions and the actors in those revolutions.

Objectives: Students will be able to:

1. Describe the process of scientific research.

2. Develop note-taking and research skills.

3. Appreciate the nature of scientific inquiry.

Subject/Grade Level: World history/grade 10; U.S. history/grade 11; sociology/grade 12, physics/grade 12

Time Required: 2 class periods to begin, plus 1 period two to three weeks later

Materials and Preparation: Become familiar with Thomas S. Kuhn's theory of scientific revolutions by skimming his book, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962). Despite the heavily philosophical style, the book reads well. Also read the **Teacher Background Information** carefully. Make copies of Handout 36-1 for all students. You may also want to make an overhead of the handout.

Procedures:

1. Distribute Handout 36-1. Brainstorm definitions for revolutions, science, structure, paradigm, and scientific revolution. Discuss the suggestions to refine and clarify them into solid definitions. Paradigm will be the most difficult for students.

   Revolution: A complete change.

   Science: A systematic process of analyzing and describing the universe.

   Structure: The unifying, controlling, and directing connections of a system.

   Paradigm: Universally recognized scientific achievements that provide model problems and solutions.

   Scientific Revolution: An episode in which an older paradigm is replaced in whole or part by an incompatible new one.

2. Begin the lecture using the **Teacher Background Information**. The example provided as an illustration of the process is the shift from the Aristotelian-Ptolemaic Universe model to that of Galileo and Newton. More recent examples can easily be developed to more closely mesh with specific course outlines. Complete the lecture by addressing questions.

3. Announce the research paper assignment. Point out that the papers should be relatively easy to write, since the structure of the paper has been clearly developed in the lecture. Reassure students that not every revolution will fit the model exactly, but that finding a revolution that does not fit may be an important result as well.

4. Brainstorm a list of topics or provide one appropriate to the era and/or topic being studied.

5. Allow the balance of the period to begin research. Papers should be due in two to three weeks (or less, if substantial class time is provided for research).

6. On the due date, collect the papers. Debrief by having selected students summarize or read their papers.

7. Renew the discussion on scientific revolutions by asking what value this type of analysis might hold for us today. The classic answer of "knowledge for it's own sake," while valid enough, seldom is convincing to students. Encourage students to consider the wider effects on society that resulted from the revolutions they researched. How was society affected? Was society affected? How directly? Was the effect apparent in the short run? Only in the long run? How were philosophy and religion affected? Did daily life change? Political life?

Evaluation:

Students' papers can be evaluated; you might also have students read and comment on each other's papers as an assessment and learning device.

Extension/Enrichment:

Students may illustrate their research projects with posters, videos, or other displays that would enhance their papers.

Resources:

Kuhn, Thomas S., *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).

Teacher Background Information:

I. Accumulation of Data. During this phase, various data are noted and collected, in no particular, coherent process. As this body of information grows, portions seem to be interrelated. **Example:** Centuries of observations of the heavens accumulate.

II. Theory Proposed. Some observer recognizes the connections in the data and proposes a scheme that unites all of the facts under one theory. The most successful theories are those that are simple as possible but still encompass all of the data. **Example:** Aristotle (384-322 B.C.) proposes the perfection of the universe. Ptolemy (85-165 A.D.) uses complex mathematics to propose a geocentric model of the universe.

III. Elevation to Paradigm. During this phase new observations continue to support the current theory. As supportive evidence accumulates, the theory increases in authority, becoming a paradigm, or controlling model for understanding the universe. **Example:** The Ptolemaic system holds sway for 14 centuries. It is bolstered by St. Thomas Aquinas' (1225-1274) scholastic reworking of the system into an acceptable Christian model, thus adding a spiritual dimension to the paradigm.

IV. Disparate Data Appear. In the course of continued intense observation, some data appear that do not fit into the acceptable ranges provided by the paradigm. Some of these data are rejected as merely spurious misreadings or malfunctions of the instruments. Some measurements may be faulty because the instruments are being pushed beyond their tolerances or resolution limits. However, as instruments are refined, and new observation methods are invented, anomalous data accumulate more rapidly. **Example:** The rediscovery of Plato's (427-347 B.C.) mathematical writings excites Nicolaus Copernicus (1473-1543) into recalculating the orbits of the planets. He proposes that the earth and other planets revolved around the sun. He reasons that since circular paths were more "perfect" than the complicated movements required by the current theory, they must be more correct.

V. Anomalies Overwhelm the Paradigm. Eventually, anomalies pile up to the point where there are more anomalies than original data. The refined instruments indicate that the new data is correct, not merely errors, and that the old paradigm can no longer be held true. **Example:** Tycho Blake builds an observatory and refines the actual observations of stellar and planetary positions. Johannes Kepler (1571-1630), using Tycho's data, again recalculates planetary orbits.

VI. Paradigm in Crisis. As long as no new theory is proposed that adequately explains all existing data, a crisis results. **Example:** From his calculations, Kepler proposes that orbits were elliptical and conformed to precise mathematical ratios that created the "music of the spheres" discussed by Plato. Galileo Galilei (1564-1642) builds a telescope and confirms Copernicus' heliocentric system and Kepler's elliptical orbit.

VII. The Outsider. Someone, usually young and either working outside the field or new to the field, proposes a radically new vision of the data that results in a new encompassing theory. These people, little committed to existing practices, are especially likely to see that the old rules no long apply, and to conceive another set that can replace them. In the emergence of Newtonian physics, and the more recent development of relativity and quantum mechanics, thought experiments played a crucial role in the process of research. That process exposed the old paradigm to existing knowledge in ways that isolated the theory crisis more precisely than could be possible in the laboratory. **Example:** Isaac Newton (1642-1727) develops calculus and works out the theory of gravity. The theory reconciles Galileo's law of inertia with Kepler's elliptical orbits and portrays the universe as an orderly, mathematically precise system. The Catholic Church is not amused.

VIII. Paradigm Shift. The new paradigm forces scientists to adopt new instruments and examine places. It also forces scientists to see new and different things when using familiar instruments in already examined places. Few paradigms triumph without a struggle. A few supporters—perhaps with suspect motives—explore, refine, and promote the new idea. If their evidence and their arguments are persuasive, the paradigm will gain favor. **Example:** Repeated observations, fueled by an increasing interest in science across Europe, result in acceptance of the new paradigm. Galileo, placed on house arrest in 1632 for the rest of his life, is recognized by the Catholic Church as having been correct—in 1985.

THE STRUCTURE OF SCIENTIFIC REVOLUTIONS

Definitions

Revolutions:

Science:

Structure:

Paradigm:

Scientific Revolution:

Lecture Notes

I. Accumulation of Data

II. Theory Proposed

III. Elevation to Paradigm

IV. Disparate Data Appear

V. Anomalies Overwhelm the Paradigm

VI. Theory in Crisis

VII. The Outsider

VIII. Paradigm Shift

Research Paper Assignment

Choose a scientific revolution to research. Write a detailed paper of at least five double-spaced typed pages. Describe events and how they did or did not fit into Kuhn's model. The introduction should clearly describe the paradigm that underwent the shift. Include a strong conclusion that discusses the value of Kuhn's model in understanding the process of the revolution you researched.