DOCUMENT RESUME

ED 363 521 SE 054 020

AUTHOR	Hassard, Jack; Weisberg, Julie
TITLE	Global Thinking. Teacher's Resource Guide.
INSTITUTION	Georgia State Univ., Atlanta. Dept. of Middle Secondary Education and Instructional Technology.
SPONS AGENCY	Eisenhower Program for Mathematics and Science Education (ED), Washington, DC.
PUB DATE	93
NOTE	230p.; A product of the Global Thinking Project.
AVAILABLE FROM	Global Thinking Project, Georgia State University, University Plaza, Atlanta, GA 30303.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01/PC10 Plus Postage.
DESCRIPTORS	Air Pollution; Class Activities; Computer Uses in Education; *Cooperative Learning; *Environmental Education; *Global Approach; *Learning Activities; Secondary Education; Solid Wastes; *Student Projects; Teaching Guides; Telecommunications; Water Quality
IDENTIFIERS	Air Quality; Environmental Awareness; Environmental Problems; *Global Education; Ozone Depletion

ABSTRACT

The teaching materials contained in this teacher's guide provide a framework for teachers in different cultures to engage their students in collaborative projects. The guide is divided into five parts. Part 1 introduces the Global Thinking Project. Three chapters provide an overview of the project, step-by-step procedures on using collaborative learning, and procedures on using telecommunications in the classroom. Part 2 engages students in a series of projects in which students will be part of a Global Community of about 10 schools world-wide. Part 3 contains three projects from which the class chooses one to work on during phase 2 of the school year together with other schools to form a global community. The projects include Project Solid Waste, Project Water Watch, and Project Ozone. Part 4 contains the project Earthmonth. During the months of March and April, students identify, prepare, carryout, and report on a local project that has global implications. Part 5 contains three appendices: Global Thinking Resources, Extension Activities, and a Student/Journal/Log. (MDH)

Global Thinking
Teacher's Resource Guide

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Acknowledgments
Many individuals have contributed to the Global Thinking Project, and we would like to acknowledge them here. Raisa Alexeyeva, Elena Antonenkova, Deborah Ault-Butenko, Marna Barnard, Boris Berenfeld, Natalia Bogdanova, Ludmila Bolshakova, Barbara Broadway, Ron Broadway, Harvey Brodsky, Ted Colton, Sarah Crim, John Davis, Sylvia Dodson, Marcia Eidelman, Phil Gang, Galina Gharavskaya, Edith Guyton, Alan Hoffman, Nancy Hoffman, Brad Holland, Marcia Humbert, Anatoly Karpov, Tatyana Khokholva, Yuvanali Koulutkin, Marina Kurbatova, Galina Manke, Alexander Martynenka, Olga Olenynikova, Gail Pappacostas, Ludmila Payula, Pat Perfetti, Dmitry Razumny, Wayne Robinson, Tim Rusnak, Peggy Sherry, Jenny Springer, Galina Soukhobskaya, Betty Jo Struchen, Susan Swanson, Katherine Taylor, Bob Tinker, Sergei Tolstikov, Simeon Vershlovsky, Tatyiana Vasilyeva, Derek Whordley, Irina Yakimanskaya, Tamara Yefimova, Inna Zabrodina, Anatoly Zakhlebny, Vadim Zhudov

Special thanks is due Augustin Dunn and Gary Lieber of Apple Computer Company, and Hayes Micromodem Company.

Several schools and school systems contributed in kind support including Chatham-Savannah, Clayton County, Cobb County, Dalton City Schools, DeKalb County, Fulton County, Gwinnett County, Rome City Schools, Walker County, Moscow School 91, Moscow School 710, St. Petersburg School 91, St. Petersburg School 157, and St. Petersburg School 239.

Some of this work was supported by a grant from the Eisenhower Higher Education Program

Some of the material in Chapter 3 was based on the *User's Manual*, Institute for Global Communications; the graphs on page 20, Chapter 2 are from *Global Warming and the Greenhouse Effect*, University of California, Berkeley.

The ALICE Network Software Quick Reference Guide is reprinted by permission of Technical Education Resource Centers (TERC).

Project Bongoh was provided courtesy of Narcis Vives, Barcelona

Special thanks to Diane Jacobi for her notes and expertise on atmospheric pollution.

Composed on a Macintosh Duo System by Jack Hassard

Contents

Part 2

Schedule for 1993 -1994

The chart below shows the schedule we will follow this year. Please try and stay on schedule during the year. We wish you the best of luck as you and your students explore the world of Global Thinking.

Figure 1. Implementation Plan of the Global Thinking Project

<table>
<tr><th colspan="3">Phase I*</th><th colspan="3">Phase II**</th><th colspan="3">Phase III***</th></tr>
<tr><th colspan="3">Establishing the Global Thinking Community</th><th colspan="3">Collaborating Globally in Environmental Projects</th><th colspan="3">Thinking Locally; Acting Globally</th></tr>
<tr><td>September</td><td>October</td><td>November</td><td>December</td><td>through</td><td>February</td><td>March</td><td>April</td><td>May</td></tr>
<tr><td>Project Hello</td><td>Project Clean Air</td><td>Project Global Thinking</td><td colspan="3">Choose from among
Project Solid Waste
Project Ozone
Project Water Watch</td><td>Preparing for---></td><td>Project Earth month</td><td>Project Evaluation</td></tr>
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</table>

CHAPTER 1

Welcome to the Global Thinking Project

After an orange cloud---formed as a result of a dust storm over the Sahara and caught up by air currents---reached the Philippines and settled there with rain, I understood that we are all sailing in the same boat.

Vladimir Kovalyonok
Russian Cosmonaut

После того, как оранжевое облако, образовавшееся в результате пыльной бури над Сахарой и подхваченное воздушными течениями, достигло Филиппинских островов и осело там с дождем, мне стало понятно, что все мы плывем в одной лодке.

Владимир Коваленок
СССР

According to many educators, the 90s will be the "environmental education" decade. Already, bumper stickers, billboards, and headlines remind us to think globally. This new awareness has prompted educators around the world to focus on environmental issues and problems from a global perspective. Students are learning that the problems and issues they tackle locally are similar to those of people around the globe, and that the actions of people everywhere have global consequences.

GLOBAL UPLINK

To help our students understand the scope and importance of environmental issues, we teach "global thinking." This is the ability to reason in terms of entire systems and to predict the consequences of altering any subpart of the system. We have created cross-cultural, interdisciplinary teaching materials that we believe will contribute to a sustainable planet by helping teachers and students to think globally. This innovative approach teaches students to identify important global problems with the help of students from another culture. The Global Thinking activities require collaboration between teams of students in different countries. This is accomplished by using the computer network established by the Institute for Global Communications. Schools in the United States are connected via EcoNet, schools in Russia via GlasNet,schools in Europe via GreenNet, and schools in Australia and New Zealand are connected via Pegasus.

This project grew out of a series of trips to the (former) Soviet Union sponsored by the Association for Humanistic Psychology (AHP). With no official invitation, a group of 30 educators and psychologists visited Moscow, Leningrad (St. Petersburg), and Tbilisi for 17 days in September 1983. Rooted in the concern for the well-being of the planet, and for improving the relationships between the people of the United States and the Soviet Union, this delegation laid the groundwork for the development of the AHP Soviet Exchange Program.

From 1983 to 1990, the AHP sponsored 12 delegations to the USSR, and received nearly a half-dozen delegations of Soviet colleagues. These exchanges fostered official agreements between the USSR Academy of Pedagogical Sciences (now the Russian Academy of Education) and the AHP that focused on humanistic and creative teaching methods, cooperative learning, and teacher education. Through seminars, classroom visits, lab demonstrations, and other informal experiences, a powerful network was established.

Georgia State University (GSU) emerged as the focal point for the AHP's educational activities with Academy of Pedagogical Sciences. An international conference on Soviet and American education led to an agreement between GSU and the APS that was signed in Moscow in May of 1989. Both parties agreed to collaborate to develop strategies, methods, and teaching materials to help students think globally. It was agreed, given the present state of the world, to develop teaching materials that would:

1. Empower students and teachers to get involved with important global problems and concerns

2. Introduce students to collaborative methods and strategies of inquiry that can be used to solve problems locally, and provide the knowledge and technological means needed to deal with problems globally

3. Develop computer literacy in students that will allow them to use microcomputers as a telecommunications tool to collaborate with counterparts in other nations.

THE GLOBAL THINKING TEACHER'S GUIDE

The teaching materials contained in this teacher's guide provide a framework for teachers in different cultures to engage their students in collaborative projects. The guide is divided into five parts as follows:

<u>Part I: Introduction to the Global Thinking Project</u> (Green tabs)

Chapter 1 Welcome to the Global Thinking Project, provides you with an overview of the Global Thinking Project, background information on global thinking, as well as instructions to help to get started with the curriculum.

Chapter 2 Using Cooperative Learning to Teach Global Thinking, provides step-by-step procedures to help you use cooperative learning. Students will work in small cooperative teams to collaborate with each other, as well as with students in other schools. Several hands-on activities are included to help you introduce cooperative learning to your students, and to get started with global thinking.

Chapter 3. Using Telecommunications to Collaborate Globally, shows you how to use the telecommunications system in your classroom. Activities are included that you should do with your students so that they understand how to use telecommunications.

Part II: Phase I Global Thinking Projects
(**Red** Tabs)

After you have introduced cooperative learning and telecommunications to your students, you are ready to engage your kids in a series of "projects." During Phase I, you and your students will be members of a Global Commnity of about ten schools world-wide. During this time your class will collaborate with other members of your Global Community on Project Hello, Project Clean Air, and Project Global Thinking.

Part III: Phase II Global Thinking Projects
(**Blue** tabs)

In Part III you will find three projects from which you should choose one to work on during Phase II of the school year. The Projects include Project Solid Waste, Project Water Watch, and Project Ozone. During Phase II your class will join with other schools working on the same project to form content-based Global Communities as follows:

- Solid Waste Community
- Watch Watch Commnity
- Ozone Community

Part IV: Phase III Global Thinking Project (Earthmonth)
(**Gold** tab)

Part IV contains one project---Project Earthmonth. During the months of March and April, your students will identify, prepare, carryout, and report on a local project that has global implications. The Global Communities established in Phase II will continue into Phase III.

Part V: Appendix
(**Green** tabs)

The appendix includes three sections: Global Thinking Resources, Extension Activities, and a Student Journal/Log.

One final note about the guide. The guide is incomplete. We see the development of the Global Thinking Teacher's Guide as an ongoing process. We welcome additional activities and ideas from you. Please note that one of the sections in the Appendix is identified as Extension Activities. If you have a Global Thinking activity that you would like to share with the project and have considered for the next edition of Global Thinking, please send a report of it to the conference: *gtp.teachers*.

GLOBAL THINKING CURRICULUM AND TELECOMMUNICATIONS NETWORK

The Global Thinking curriculum consists of a series of engaging projects that involve your students in adventures of collaboration with kids in other schools not only in your country, but in other countries. The content of the projects is global environmental education. Students will learn how to monitor important physical and biological aspects of their environment in order to study topics such as weather and climate change, air pollution, water pollution, acid rain, ozone, solid waste management, and global warming. Monitoring is the first step in developing an understanding of global environmental problems. We go beyond this step by providing students with opportunities to apply their "new" knowledge by engaging in cooperative team projects that link students in classrooms globally.

Global Thinking Learning Model

Each project is organized as a learning cycle. We begin by helping students' elicit their *prior experiences* and knowledge, and then engage the students in the *exploration* and *development of concepts* about an environmental topic (air quality, water quality). Finally students apply their knowledge by participating in *action taking* projects. These four stages--eliciting prior knowledge, exploring, developing concepts, and taking action--define the constructivist learning model (see the figure below) we have used in the development of the Global Thinking "projects."

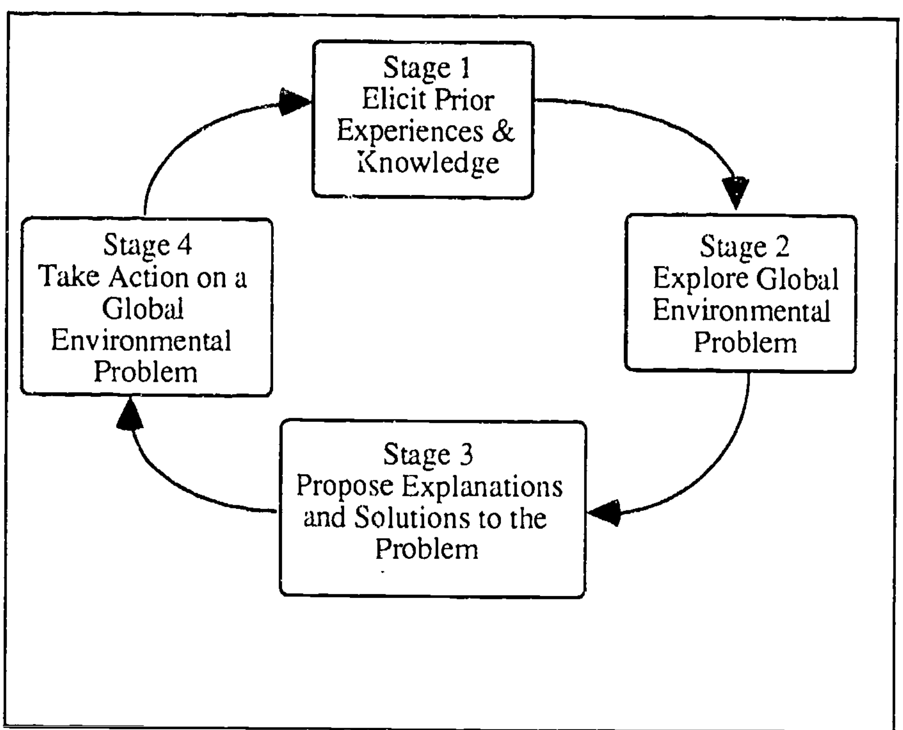


Figure 1. Global Thinking Learning Cycle

Global Thinking "Projects"

As shown in the figure below, the curriculum of the Global Thinking Project is organized into a sequence of "projects." The first three projects are to be completed first, and in the sequence presented. When your class has finished these projects, then you and your students will choose from among other projects.

Projects "Hello," "Clean Air," and "Global Thinking" will help launch you and your students into the world of global thinking, environmental education, and telecommunications. We have designed and sequenced these projects to help you and your kids enter into the world of global environmental thinking.

Figure 2. Implementation Plan of the Global Thinking Project

Phase I*			Phase II**			Phase III***		
Establishing the Global Thinking Community			**Collaborating Globally in Environmental Projects**			**Thinking Locally; Acting Globally**		
September	October	November	December	through	February	March	April	May
Project Hello	Project Clean Air	Project Global Thinking	Choose	from Project Solid Waste Project Ozone Project Water Watch	among	Preparing for--->	Project Earth month	Project Evaluation
*During Phase I, each school will be assigned to a *Global Community* comprised of 8-10 schools. Schools within a Global Community will send electronic mail to each other, as well at to the gtp.earthconf.			**During Phase II, schools will be assigned to either the Solid Waste Group, Ozone Group, or Water Watch Group depending upon the Project each school wishes to study. Electronic mail will be sent among schools within the same Group.			***Schools will continue to work with the Phase II Global Community		

During **Phase I**, your students will explore their own environment, gather and share data on environmental problems, learn how to work together in small cooperative teams, and how to use telecommunications to collaborate with peers in other schools. To increase the quality of collaboration, and to make telecommunications more personal, your school will be assigned to a Global Community consisting of eight to ten schools from around the world. During Phase I, your students will send and receive electronic messages from all schools in your Global Community. This will promote friendship, and facilitate collaboration betweeen your class and others in the Global Community.

When you have completed these three projects, your class will move to **Phase II** of the Global Thinking Project. In the second Phase, you and your students will be on your way to explore other pressing global environmental problems, but based on your choices. You will be asked to choose to study one proejct from among several. Schools in the Global Thinking Project will be re-grouped based on the content of the project. Global Communities based on the content of the Project will work together to investigate environmental problems related to air, water or land.

Finally, in April, the entire Global Thinking Project will join together during **Phase III** to participate in Project Earthmonth. Project Earthmonth is designed to help your students culminate their work by identifying and working on an environmental project, as well as participating in global telecommunications forums.

Each project contains a series of lessons, activities, and evaluation suggestions, and is contained in a separate section of the teacher's guide. The information for each project is a guide for you and your students. We encourage you to experiment with the ideas and suggestions, make modifications, and suggestions to us as to how to improve these materials.

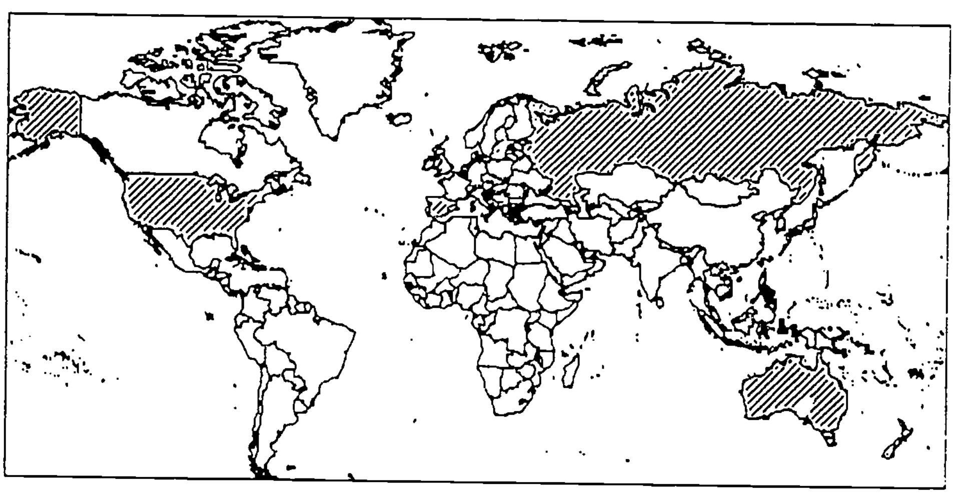
The Global Thinking Telecommunication Network---A Community of Practice

Providing real-world opportunities to collaborate with peers in other schools and countries is one of the compelling contributions that telecommunications can make to your students. The Global Thinking Project links schools together using the EcoNet telecommunications system. EcoNet is part of the Institute for Global Communications. Schools outside the United States link with the project by means of affiliated networks around the world. For example, the Russian schools have accounts on GlasNet, European schools are linked via GreenNet, and Australian and New Zealand schools are linked via Pegagus.

Using Macintosh or IBM-based computers, you have a direct link to the Project schools. Using EcoNet, GlasNet, GreenNet, or Pegasus teachers and students can send e-mail (electronic mail) to any user in the system. In fact, because of InterNet connections, e-mail can sent to and received from almost anyone on any telecommunications system in the world!

Schools in the Global Thinking Project use the Alice Network Software developed by TERC. The Alice software enables students to send reports and data tables accross the network. Students also use the software to analyze data, create graphs, and map the results of their work. More details about the Alice Network Software can be found in Chapter 3

Each school in the Global Thinking Project is assigned to a working and collaborative Global Community. Each Global Community is comprised of about 10 schools from countries around the world. Schools within a Global Community work together to learn about each other, and the environment. Within each Global Community, email messages are sent to each member of the group, as well as to the *gtp.earthconf.*



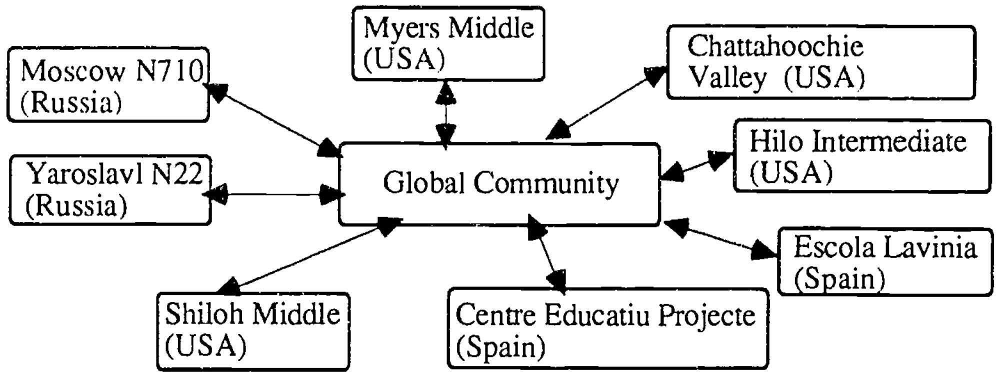


Figure 3. A Global Community of Practice. Schools in the Global Thinking Project are organized into Global Communities of about ten schools. During Phase I of the Project, schools within each "community" collaborate with one another.

The Global Thinking Project also has several conferences (electronic bulletin boards) on EcoNet. These conferences will create electronic environments enabling teachers and students in the project to interact publicly with each other. Since the Global Thinking Project will have several Global Communities working simultaneously, the conferences will provide an electronic environment enabling all Global Thinking Project schools to communicate with each other.

THE GLOBAL THINKING PHILOSOPHY

Helping students around the world understand that a sustainable planet is in the best interests of all nations is a major focus of the Global Thinking Project.

Two main concepts underlie the philosophy of the project: anticipation and participation. Anticipation in learning is the capacity to face new situations. It is the ability to deal with the future, to predict coming events, and understand the consequences of current and future actions. Anticipation also implies "inventing" future scenarios, and developing the philosophy that humankind can influence future events.

Participation, on the other hand, is the complimentary side of anticipation. Students must participate directly in learning. The learning model that underlies the Global Thinking Project is based on these two ideas:[1]

- knowledge is not passively received but actively constructed by the student.
- the function of cognition is adaptive and it organizes the experiential world.

These two principles of learning form the basis for constructivist learning, and form the basis for the Project's approach to learning.

[1] Von Glasersfeld, Ernst (1989). Constructivism in Education. In *The Internatinal Encyclopedia of Education---Research and Studies---Supplemenary Volume One*. Eds. Torsten Husen and T. Neville Pstlewaite. New York: Pergamon Press.

The EcoNet, Glasnet, and GreenNet telecomputing networks enable students to participate not only on a local level, but on a global one, as well. Students in the project will participate in learning activities that stretch their range of participation to include the entire planet.

The global problems that your students will investigate (air pollution, acid rain, solid waste management, water pollution, ozone) have local causes. Because of this, your students can be involved in not only learning about them, but participating in solutions to them as well. A quote from the book, *No Limits to Learning* aptly sums up our attitude about global participation:

Participation in relation to global issues necessarily implies several simultaneous levels. On the one hand, the battleground of global issues is local. It is in the rice fields and irrigation ditches, in the shortages of over-abundances of food, in the school on the corner and the initiation rites to adulthood. It is in the totality of personal and social life-patterns. Thus participation is necessarily anchored in the local setting. Yet it cannot be confined to localities. Preservation of the ecological and cultural heritage of humanity, resolution of energy and food problems, and national and international decisions about other great world issues all necessitate an understanding of the behaviour of large systems whose complexity requires far greater competence than we now possess. The need to develop greater competence and to take new initiatives is pressing. For example, during times of danger or after a natural catastrophe, nearly everyone participates. Can we not learn to participate constructively when animated by a vision of the common good rather than a vision of the common danger?[2]

What is Global Thinking?

Shortly after World War II ended, in May 1946, Albert Einstein wrote a fund-raising letter for the Emergency Committee of Atomic Scientists. He started out his letter by saying:[3]

Our world faces a crisis as yet unperceived by those possessing the power to make great decisions for good or evil. The unleashed power of the atom has changed everything save our modes of thinking, and thus we drift toward unparalleled catastrophe.

Later in the letter he stated, "We need $200, 000 at once for a nation-wide campaign to inform the American people that *a new type of thinking is essential if mankind is to survive and move toward higher levels.*"

Although Einstein didn't say it directly, perhaps he meant systemic or holistic thinking was required if we were to survive. Perhaps the mode of thinking Einstein envisioned was global. If we look around at the major problems and issues facing the earth today, most have global causes and effects. Even though problems like ozone depletion, climate change, and acid rain can be traced to actions and activities at the local level (including households), the effects of these problems are global. And indeed the causes can be traced to global systems. Thus it is important---perhaps because we live in a world that is global---that students be helped to understand and cope with problems in this way.

Another scientists, but living in a different culture, who recognized the need for a new way of thinking was the Russian scientist Andrei Sakharov. In 1962, Sakharov advised the Soviet government that atmospheric testing of nuclear weapons should be banned. Although Sakharov was wasn't successful at first in convincing his government, his

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[2] Botkin, J.W., Elmandjra, M., and Malitza, M. (1979). *No Limits to Learning*. Oxford: Pergamon Press.

[3] Excerpted from Holt, Robert R., "Can Psychology Meet Einstein's Challenge." *Political Psychology*, Vol. 5, No.2, 1984, p. 199.

dissident views eventually led to the banning of atmospheric testing, thereby protecting the planet from the effects of nuclear fallout.

About the same time that Sakharov began to speak out about nuclear testing in the atmosphere, Rachel Carson warned all citizens that living things faced disaster and that a "silent spring" might occur. Her book by that title succinctly described the global links in the biosphere, and deadly effects of some chemical sprays (especially DDT) on the pyramid of life. Carson's book led to legislation in the U.S. Congress that eventually put some controls on the use of certain chemicals for the control of "weeds" and "pests." Rachel Carson helped the ordinary person understand the interdependence among living things from the tiniest plankton to the largest of whales, thereby setting in motion the beginnings of the environmental movement that was given impetus later by the first Earthday in 1970, and more recently marked by the Earth Summit in Rio de Janeiro in 1992.

Global Awareness and the Gaia Hypothesis

Global thinking stimulates an awareness of the planet Earth was surely manifested when pictures were sent back to Earth by Apollo astronauts giving single-celled picture of Earth. Looking back toward Earth, astronauts and cosmonauts saw at once that the Earth was whole. Yet this new awareness was more than a visual picture of the Earth, it led to something more powerful. Global Awareness implies that things are connected, that the atmosphere over Toledo, Ohio can affect the trees in Canada, that clear cutting the forests of Brazil could change the temperature of Moscow, and recycling newspapers could reduce the chances of oil spills.

And just as the space age has given us new visual images of Earth, it has led to new questions and theories. One of the scientists to work on the Martian project that looked for signs of life on the "red planet" was James Lovelock. Lovelock and his colleagues on the Martian project devised a number of "life-detection" experiments. One of their suggestions was that a planet bearing life might have an unexpected mix of gases in its atmosphere if life's chemistry were at work. Dr. Norman Myers, editor of GAIA: An Atlas of Planetary Management, describes Lovelock's breakthrough this way:

When they looked at Earth in this light (having an unexpected mix of gases), their predictions were borne out with a vengeance. Earth's mix of gases, and temperature, were hugely different from what they predicted for a "nonliving" Earth, as well as from neighboring planets. The fact that these conditions appeared to have arisen and persisted alongside life led to the Gaia hypothesis---the proposal that the biosphere, like a living organism, operates its own "life-support" systems through natural mechanisms.[4]

What Lovelock and microbiologist Lynn Margolis, co-author of the Gaia hypothesis, suggested was that the earth's atmosphere was not simply a product of the biosphere but was a "biological construction---like a cat's fur, or a bird's feathers: an extension of a living system, designed to maintain a chosen environment".

The Gaia hypothesis is a useful concept to help students think about the interrelationship of Earth's basic resources---energy, water, air, and climates. According to the Gaia hypothesis these elemental resources can be radically affected by changes in any one of them. Many of the projects in the Global Thinking curriculum focus on these elemental resources, and enable students to get involved by monitoring them, asking questions about them, and conducting projects to find out more about them. It also should be

[4]Norman Myers, ed., *GAIA: An Atlas of Planetary mangaement* (Garden City, N.Y.: Anchor Doubleday, 1984), p. 13.

pointed out that the management of these elemental resources is what many environmental action groups advocate.

Global awareness and the Gaia hypothesis support a new way of reasoning about the earth, its environment, and inhabitants (all living things), namely global thinking.

An Alive Planet?

Space age explorers were not the first to think of the Earth in this way. A Scottish scientist, James Hutton (a geologist) proposed in 1785 that the Earth was a living super organism. He actually suggested that the science of the Earth should be physiology! It 's odd that the "father of geology" would perceive the solid Earth as a living organism.

Another scientist that viewed the Earth as alive planet was Vladimir Iranovitch Vernadsky, a famous Russian scientist (1863 - 1945). Vernadsky, perhaps as much as anyone, laid the foundation for global thinking. Vernadsky is credited by inventing several fields of science, each of which was characterized by interdisciplinary study. For example, one field he suggested was biogeochemistry, literally the integration of biology, geology, and chemistry.

But perhaps more pertinent to global thinking is the fact that Vernadsky coined the concept of "biosphere." He encouraged scientists to focus their attention on the "sphere of life." According to Vernadsky the so called living and nonliving parts of the Earth were interdependent and tied to each other. In fact Vernadsky called life a "disperse of rock." To him life was a chemical process in which rock was transformed into active living matter and back, breaking it up, and moving it about in a never ending cyclic process.

Global Thinking Themes and Propositions

What assumptions about learning and thinking are evident in the Global Thinking Project? As students investigate global problems and issues using the structure of the Global Thinking Project, a number of themes will be evident. Themes relate to the philosophy of a project, and thus the themes (also called propositions) listed below define the philosophy and approach of the project.

Theme 1: Systemic reasoning. Global thinking is a systemic process of reasoning. Students can be taught to think in terms of complete systems as well as to describe and predict the consequences of changing any aspect of a system.

Theme 2: Anticipating the Future; Participating Now. Global thinking involves elements of anticipation and participation. Anticipation means be able to confront new situations and to envision future scenarios. Participation means direct and active involvement in learning. Students can be taught to anticipate global problems and to participate in problem solving on a local level.

Theme 3: Attitude. Global thinking is an attitude that can be taught and developed.

Theme 4: Knowledge construction. Global thinking concedes that knowledge is constructed by the student rather than being passed directly from teacher and student. Students' prior constructions of knowledge will greatly influence what is learned about global thinking.

Theme 5: Thinking Globally. Global thinking as a curriculum helps teach students to think globally by working with a community (Global Community) of schools on a series of problem solving activities.

Theme 6: Telecommunications. Global thinking as a telecommunications system empowers teachers and students to work with distant partners in taking an active role in solving global problems.

Theme 7: Creativity. Global thinking encourages creativity as students are challenged to brainstorm, propose alternative solutions, and communicate with students in another culture about environmental or other common problems.

Theme 8: Responsibility. Global thinking empowers students to take individual responsibility in the classroom as well as to develop personal strategies for becoming active world citizens.

Theme 9: Process. Global thinking is designed for a wide range of abilities, interests and backgrounds of students. The teaching-learning process does not rely on reading, but instead engages students in writing, discussing, drawing, experimenting, collecting and analyzing data, reporting data, communicating and generating theory.

Theme 10: Teachers as a facilitators of learning. Global thinking characterizes the teacher as a facilitator of the learning process, rather than a transmitter of information. The teacher guides the students in working cooperatively with their own classmates, as well as with their classmates in their Global Community.

Student Outcomes

What will students learn as a result of participating in the Global Thinking Project? There are two sources of outcomes within the Global Thinking Project materials. First, if you take a moment and turn to the first project, Project Hello, you will note that each activity is defined in terms of objectives. These objectives describe the learning outcomes students should be expected to attain for each project. Most of these objectives relate to the specific "content" of each project, such air pollution, water pollution, solid waste management.

There are also some overarching outcomes that should be expected as well. Participating in a project that is global in scope should lead to the following outcomes:

Overarching outcomes:

1. Students should develop the ability to "think globally and act locally."

2. Students should develop the ability and willingness to enter into "dialog."

3. Students should develop increased awareness of the interrelatedness of the environment.

4. Students should develop the ability to ask higher order questions, and the process and skills to answer their questions.

5. Students should move toward higher levels of thinking (Piaget and Vygotsky), higher levels of moral thinking (Kohlberg), and a higher state of consciousness (Wilber).

6. Students should expand their perceptions of self and their environment (Maslow).

7. Students should develop a heightened sense of personal responsibility for planetary conditions.

8. Students should develop an expanded sense of information sources.

9. Students should develop a greater sense of self.

Students' Conceptions of Global Thinking

Students possess a variety of prior concepts about global thinking. Student conceptions of global thinking include notions such as these:

"Global thinking is thinking how our actions and reactions affect all the world." (female, age 13)

"Thinking about the world as a whole, as one, not separated by continental boundaries or individual politics." (male, age 13)

"I think thinking globally is when the Earth's people think as one about the Earth's problems and take responsibility for their share in the creation of those problems." (male, age 12)

" Thinking globally means thinking with and about the whole world." (male, age 13)

"Global thinking is when everyone on the earth thinks of each other as one." (female, age 13)

"Thinking of the world as a whole with differences but not divided." (male, age 15).

Students' conception of global thinking should be affected as a result of studying and experiencing activities in the global thinking project. You will find questions in the student projects that follow later in this teacher's guide that you can use to monitor how your students' ideas change while participating in the project.

Note: When you introduce the Global Thinking Project to your students, you might have them discuss and write about global thinking. To do this, ask each student to "think" about the term "global thinking." Then have them think about how a person who is a global thinker would behave. Then have then turn to a person sitting nearby and share their ideas. Finally give each person a few minutes to write about global thinking. You might want to share some of your students' ideas on the computer network.

ESTABLISHING A GLOBAL THINKING CLASSROOM

The materials in the Global Thinking Teacher's Guide are designed to help you establish a global thinking environment in your classroom. Many of you will be integrating the activities in this guide into your science or social studies course. Others will be using GTP in after school science clubs, or in Saturday science programs. We hope that by doing so, the experience will have a profound impact on the way your students think about people in other cultures, the environment and how technology can be used creatively and for the betterment of humankind.

To give you a flavor, here are brief discussions some things to think about before moving on in the guide:

- The content of the Global Thinking Project
- The use of technology
- Cooperative learning
- The role of the teacher

The Content of Global Thinking Project

The Global Thinking project integrates environmental education, cooperative learning and technology enabling your students to become part of community of global thinkers. They hopefully will be become concerned about the environment, from a local as well global perspective, learn how to investigate global problems, and be exposed to ways to take action on the problems they consider to be important.

From the student's perspective, the content of the global thinking will be explored through a series of "projects." Projects are modules of learning focusing on some aspect of the environment. For example in Project Clean Air, students are introduced to air pollution learning how to monitor two types of air pollution, particulates and ozone.

We have organized the content of the curriculum into three Phases. The chart below (Figure 4) shows this organization, and lists the content of the Global Thinking Project Curriculum.

Phase I*			Phase II**			Phase III***		
Establishing the Global Thinking Community			**Collaborating Globally in Environmental Projects**			**Thinking Locally; Acting Globally**		
September	October	November	December	through	February	March	April	May
Project Hello	Project Clean Air	Project Global Thinking	Choose	from	among	Preparing for--->	Project Earth month	Project Evaluation
				Project Solid Waste				
				Project Ozone				
				Project Water Watch				

Figure 4. Organization of the Global Thinking Project Curriculum

The Use of Technology to Create Communities of Practice

Whether you are a teacher in Russia, Spain, the United States, Australia, New Zealand or the UK., you have entered into the world of distance education by the fact that you are using computer technology in your classroom to link your students with students in distance schools and countries. The Global Thinking Project has developed learning materials that can facilitate student understanding by using telecommunications. Each classroom participating in the project will house a computer, modem, and printer, and be linked to the EcoNet, GreenNet, GlasNet, or Pegasus telecommunications systems. The technology provides a way to link students in distant places to collaborate on the study of global problems. To facilitate the concept of "community of practice," each school in the project is a member of a Global Community. Global Communities consist of eight to ten schools (see Figure 3). The success of each Global Community will be dependent upon the nature of the communication among the schools in the community. Responsibility for sending and responding to e-mail rests with each school.

Cooperative Learning

Learning can be enhanced powerfully by having students work in small, mixed-ability teams. Teams comprised of from two to four students work best, and can facilitate work not only when students are doing activities in the classroom, or collecting data outside, but when they use the computer. The essence of cooperative learning is establishing an environment within teams that fosters interdependence as well as responsibility. The activities in the Global Thinking Project have been designed and written with these concepts in mind.

The Role of the Teacher

The Global Thinking teacher is a facilitator of learning, and is rooted in ideas developed by American psychologists such as Carl Rogers, and Russian psychologists and educators such as Galina Soukhobskaya. In their view, the learning environment should be student (or person) centered, and the teacher should try and establish an environment in which students solve problems, ask questions, and inquire into a variety of issues, concerns and problems.

The teacher's role is not a passive one; rather, it is an active one. Your role will include helping your students take responsibility for their learning, stage interesting activities that will engage them, and give them the opportunity to use the computer and the telecommunications system to interact with their global partners.

Recent research by cognitive scientists suggests that knowledge is constructed by the learner. In this constructivist view, students are builders of their own knowledge. The teacher's role in the constructivist learning model is to support student construction by creating an environment where students are encouraged to identify and solve problems, discuss their ideas with peers and adults, test ideas, as well as hypothesize and apply their ideas.

Your role will be to establish a social environment in which students are organized into small teams that explore the "projects" that we have designed for their investigation. Facilitating cooperative learning among the teams in your class, and helping them become linked with student teams in other schools will be your principle role.

Looking Ahead

If you feel your students need practice understanding cooperative learning, or understanding the role of telecommunications in the Global Thinking Project, you might want to do one or two activities from Chapter 2 and/or 3.

If not, you should get started immediately with **Project Hello**.

HELP

If at any time you need an answer to a question about the Global Thinking Project you can post your question in this Global Thinking Project:

gtp.teachers

You can also contact the Global Thinking Project as follows:

Dr. Jack Hassard	jhassard@igc.apc.org
Dr. Julie Weisberg	jweis@igc.apc.org
Mr. Wayne Robinson	wcsc@igc.apc.org
Dr. Roger Cross (Australia)	rcross@peg.apc.org
Dr. Galina Manke (Russia)	armu@glas.apc.org
Mr. Narcis Vives/Anna Pinero (Spain)	nvives@ac.upc.es

Using Cooperative Learning to Teach Global Thinking

As I looked down, I saw a large river
meandering slowly along for miles,
passing from one country to another
without stopping. I also saw huge
forests, extending across several
boarders. And I watched the extent of
one ocean touch the shores of separate
continents. Two words leaped to
mind as I looked down on all this:
commonalty and interdependence.
We are one world.

John-David Bartoe
American Astronaut

This chapter describes how to get started with the Global Thinking Project curriculum by providing a series of activities designed to help students learn to work together in small, mixed-ability cooperative teams. Cooperative learning is model of teaching in which small groups of students---usually no more than four to a group---work together to complete a task. Tasks may include activities to solve problems, design an experiment, work on a project, make a class presentation, prepare an e-mail message, read a report on a global issue, or review and study for a quiz.

QUESTIONS ABOUT COOPERATIVE LEARNING

What is cooperative learning?

Cooperative learning, in the context of global thinking, is a model of learning in which small teams of students cooperate to solve problems about the earth's environment. Not only are students cooperating with peers in their own classrooms, but they collaborate with students in other classrooms and other cultures that are members of their *Global Community*.

Why cooperative learning and global thinking?

The solution to most of the problems that students will explore in the Global Thinking Project require cooperation among the people and governments from different nations. The deterioration of ozone in the stratosphere, destruction of trees and other plants by acid precipitation and ozone, and the gradual rise of the Earth's temperature are problems that have multi-national causes, and will require global solutions. Helping students learn how to collaborate globally empowers students to take action on environmental problems.

One of the aims of the Global Thinking Project is to create a global community of student learners who are committed to collaborating on important global problems and issues through discussion and joint projects. Students who are involved in cooperative learning activities learn the collaborative strategies and skills needed to do this kind of work.

What are the principles of Cooperative Learning

Buckminster Fuller was a proponent of the concept of synergy, as was the Russian psychologist Lev Vygotsky. In a synergic system, the whole is greater than the sum of the parts. In a cooperative group, the creative potential of the group is greater than sum the individual potential of each group member.

Cooperative learning is based on the notion of positive interdependence. That is, in cooperative groups, one of the goals of the group is to create an environment in which one team member's success, idea, or solution depends on the successes, ideas and solutions of other members. Cooperative groups work because an "all for one and one for all" attitude prevails in the group.

The Global Thinking Project is committed to developing teaching and learning materials that promotes positive interdependence among students of the same class, as well as from class-to-class, and from country-to-country.

The essential aspects of cooperative learning consist of the following:

- positive interdependence
- individual responsibility
- face-to-face interaction
- small group collaborative skills
- group processing

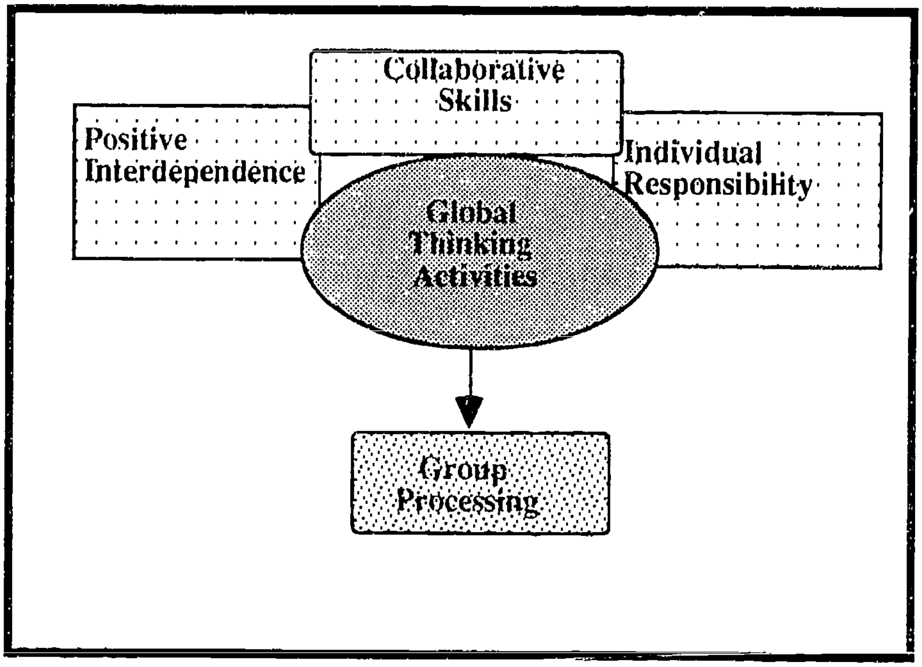

Figure 1. Elements of Cooperative Learning

Figure 1 shows the relationship among these elements. Here, very briefly, is a discussion of each of the elements.

Principle 1: Positive Interdependence
Positive interdependence is achieved when each group members' actions are essential for group success. Interdepdence can be achieved by giving each student an assigned role in Global Thinking activities, by having the team be responsible for a single report (such as message they are to write to the network), by having students take turns during an activity, or using experts who must then share their knowledge with the whole group.

Principle 2: Individual responsibility
Individual responsibility comes about when we provide opportunities for individual students to make important contributions to the group. This can be done by dividing up the labor of an activity, assigning a different role to each student, and encouraging students to take personal responsibility for the success of the small group.

Principle 3: Face-to-Face-Interaction
Face-to-face interaction provides the opportunity for your students to meet each other on common ground, and to influence each others social as well cognitive abilities and thinking. Keeping groups small (2 to 4) enhances this potential.

Principle 4: Small Group Collaborative Skills
Small group collaborative skills are essential for the success of cooperative learning groups. Students need assistance with these skills, just as they need assistance when you teach them a new science skill, such as reading a thermometer, using a sling psychrometer, interpreting data, or making a graph. Students need to know how to work

with each other, how to communicate their ideas, how to accept and support the group, and how to deal with conflicts in the group.[1]

Group Processing

Group processing enables students to reflect on their group work. In a group processing session, students can evaluate how well they worked together, and what they might do to improve. These debriefing sessions enable students to participate in reflective thinking sessions in which they give and receive feedback, and think about future actions in group work.

Helping Students with Skills of Collaboration

Generally speaking, students need to be taught the skills of collaboration. Just as students need to learn the skills of science, such as observing, measuring, and data collection, students need to learn the interpersonal skills of collaboration.

Teamwork requires that students use interpersonal such as sharing ideas, listening actively, encouraging participation, sharing labor, encouraging others to talk, generating alternative ideas, and taking different perspectives.

Johnson, Johnson and Holubec[2] have divided interpersonal skills into four levels, and suggest that these levels be used to help your students with collaboration. The levels of collaborative skills include:

1. Forming: These are base-level skills needed to establish a group. Examples include encouraging everyone to participate, moving into groups without undue noise, eliminating put-downs.

2. Functioning: These are skills needed to manage the group's work to complete activities and maintain teamwork. Examples include taking turns, following procedures for an activity.

3. Formulating: These skills are needed to enable the team to build a deep understanding of the content of the Global Thinking projects, and to stimulate higher level reasoning in the team. Assigning roles to the students including communicator, materials manager, checker and tracker provides a way for teams of students to process their work.

4. Fermenting: These skills are needed in the Global Thinking Project to enable students to conceptualize global problems, as well as deal with the conflict that might exist between their prior knowledge and the concepts that you introduce. Further, your students will be engaged in the search for information on global problems, will be communicating with peers not only in their own class, but with peers in other classes in other nations. To do these things your students will need to be able to criticize ideas, not the person, disagree in an agreeable way, take different perspectives, generate alternative ideas, ask questions, and ask for explanations.

The skills of collaboration need to taught directly to students, and in the context of the Global Thinking activities. First you should decide which skills your students need, and

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[1] Johnson, David, Johnson, Roger T. & Holubec, Edythe Johnson, Circles of Learning: Cooperation in the Classroom. Edina, Minnesota: Interaction Book Company, 1990, p.15.

[2] Johnson, David, W., Roger T. Johnson, and Edythe Johnson Holubec (1990). *Circles of Learning*. Edina, Minnesota: Interaction Book Company, pp. 92 - 96.

then introduce them one-at-a-time. A technique that has been used by many teachers to teach collaborative skills is the T-chart. T-charts summarize the characteristic of a skill, and is used to help the students use the skill during an activity. Ask students to generate a list of what the skill "sounds like", and what it "looks like". Hang the chart in the class and have the students practice the skills during an activity.

T-Chart
Active Listening

Sounds Like	Looks Like
• Say "uh-huh" as speaker talks	• Nod
• use open-ended questions to keep the speaker talking	• Eye contact
• Paraphrase what the speaker says	• Lean forward
• Accept what the speaker says rather than give your opinion	• Smile
• Summarize the speakers comments	• Relaxed posture
	• Hands unclenched
	• Arms not crossed

Figure 2. T-Chart for the Collaborative Skill "Active Listening."

Forming Groups in the Global Thinking Classroom

We recommend that you divide your students into teams composed of four students. In general the teams should be of mixed-abilities, and include both boys and girls. In some cases, you may want to form smaller teams. If so we recommend pairs of students.

Here are some general principles to consider when forming groups.

• Change the composition of groups from time to time. Groups need to be together long enough to get to know each other, and to have the opportunity to be successful. You might want to keep groups together for each Phase of the Project.

• Once groups are formed, provide time for students to get to know each other by doing a warm-up activity (e.g. sharing something about themselves, making a team banner, having the students send a message to another team describing their interests and goals).

• Use random methods to form groups. Distributing colored cards, and then having teams form based on the distribution is one simple way. Other ways include counting off, distributing cards with pictures (see Figure 3) of (organisms, pollution, seasons of the year, etc.), and then telling students to form groups on the basis of the characteristics of the cards. Remember that your goal is to form heterogeneous teams of students.

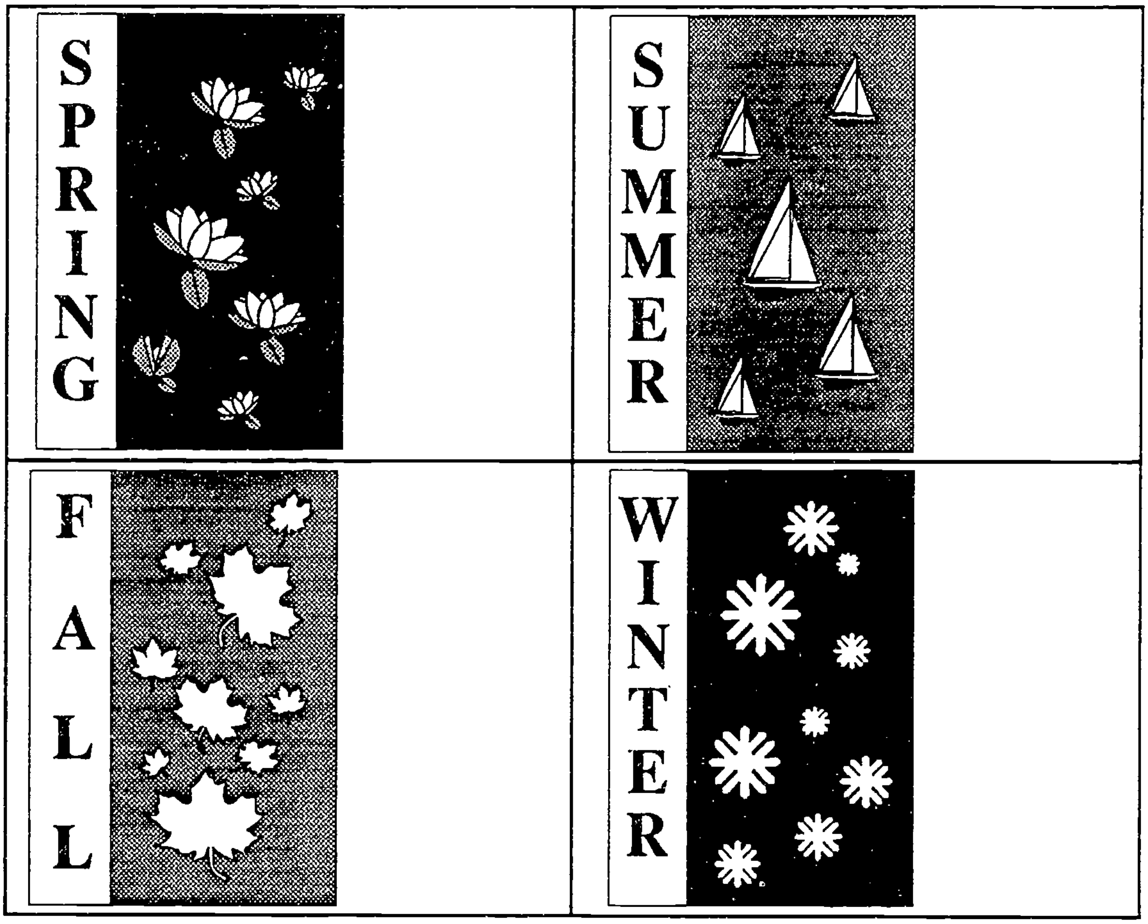


Figure 3. Equinox/Solstice Cards. Use these cards to form teams. Make enough copies so each person in your class gets one card. Tell students to form teams of four such that each team is composed of four persons, each with a card from each season. If you do this as your first activity, you can have students brainstorm what they know about each season, and discuss the concepts of equinox and solstice.

Student Roles

When students work in groups, we have found that it is useful to assign a role to each student. This promotes interdependence among group members, and helps each student develop personal responsibility for some aspect of the activity. The roles that we have found successful are as follows:

- Communicator
- Tracker
- Checker
- Materials Manager

The distribution of roles within a group is based on function, and consequently each role implies a different "job." There is no hierarchy implied, thereby removing the bias that one job is more or less important than another. Our goal here is shared leadership and teamwork.

When you first introduce your students to the roles that they will be assuming in Global Thinking activities, you should spend time discussing the function of each role. Giving each team member a card with a brief description of the function of the role will help. Make copies of the template of student roles shown in Figure 5 and distribute them to each team.

Here briefly is a description of each role.

Communicator	Tracker
The communicator is responsible for asking the teacher or another team's communicator for help if the team gets stuck. If the team cannot resolve a question or decide how to follow a procedure, for example, the communicator is the only team member who can leave the team and ask the teacher for help or talk with the communicator of another team. The communicator shares with other teammates any information obtained from another communicator or the teacher. The communicator is the computer operator for the team, and is responsible for keyboarding team messages, and being responsible for informing the team of messages received from other teams.	The tracker is responsible for tracking the team's progress through the steps of a Global Thinking activity. The tracker might point to each step of the procedures as the team completes each step, or remind the team members to read the step again if they are moving too quickly onto to the next step. The tracker is responsible for recording information for activities that require only a single team record, and should work directly with the communicators when preparing e-mail messages to other schools, or messages to the Global Thinking conferences.
Checker	**Materials Manager**
The checker is responsible for making sure that the team understands and completes the team task. When the team begins a Global Thinking activity, the checker makes sure that everyone understands the activity, and helps the team discuss the task before beginning. During an activity, the checker should facilitate and encourage talk about the activity. In general checker are facilitators of the team actions on the activity, but should not be construed as the leader of the team.	The materials manager is responsible for picking up and returning all supplies and equipment that the team needs for an activity. Materials managers also take responsibility for the making sure equipment, especially monitoring tools, are in good working order, and if something is damaged or broken, informs the teacher. Materials managers facilitate clean up; all members should participate in clean up!

Figure 4. Description of Cooperative Learning Student Team Roles

Using roles in the Global Thinking activities helps promote positive interdependence as well as individual responsibility. The first time you use roles with your class you should help students:

• Understand the function of their roles. Make copies of the "cooperative team role cards" in Figure 5. Cut the cards out, and distribute a set of them to each team. Students should fold the cards, and set them on their desk.

• Know why roles are important; here you make a link to the practice of real science by telling students that most scientists work in teams rather than as isolated investigators.

• Process how effectively they carried out their roles. After the first activity have each team discuss within its group how well team members carried out their roles.

Communicator • Helps Resolve Problems • Can Leave Team to Communicate with Teacher or other Communicators • Transmits Messages on the Telecommunications System, and Informs Team of Messages from Other Teams	**Tracker** • Helps Track Progress • Records Data/Information for the Team • Collaborates with Communicator on e-mail and conference messages
Checker • Helps Team Understand the Activity • Facilitates Talk About the Activity • Is not the Leader; Is a Facilitator	**Materials Manager** • Picks Up/Returns Materials • Facilitates Clean-Up • Checks to Make Sure Equipment is in Working Order

Figure 5. Cooperative Learning Team Role Cards. (Make a copy of these cards for each team. Cut the cards up, and distribute them to the members of each team. Cards can folded and set on the team's table to remind students of their role.)

COOPERATIVE TEAM BUILDING ACTIVITIES

The activities that follow are designed to give your students practice working in cooperative small groups, as well as to provide an introduction to the Global Thinking Project.

You should complete each of these activities with your class before moving on to Chapter 3.

Planning Chart: Team Building Activities

Activity	Title	Telecommunications Alert	Time Allotment
1	Global Thinking: The Big Picture	none	1-2 sessions
2	Problem on the Way to Mars	none	1 session
3	Is the Earth's Climate Changing?	none	1 session

1 session= one 45-60 minute class period

Cooperative Team Building Activity 1

Global Thinking: The Big Picture

In this activity, students are introduced to the Global Thinking Project. To do this, they will be involved in a warm up activity to find out what they know about global thinking. Then they wili be randomly assigned to a team, and participate in a cooperative learning activity.

Objectives
• describe the nature of the Global Thinking Project
• ascertain what students know about global thinking
• work as a team to complete a task

Materials
Copies of the handout, "Finding Out Who We Are ," (Figure 6), "Equinox/solstice cards," (See Figure 3), crayons or marking pens, large sheets of newsprint paper, map of the world or a globe

Procedure
1. After your class has arrived and settled in your room, distribute one copy of the five minutes (ten minutes if you want more time) to get as many initials as possible of people in your class who fit the descriptions given in the handout. After the allotted time, take a few minutes to poll the class on their responses to some of the items. Ask questions such as, "How many of you got an initial for someone who speaks a foreign language." Students raise their hands. Spend just a few minutes on this to get a feel for the kinds of experiences your students have had with foreign language, travel, and global thinking.

Finding Out Who We Are

Directions: You have five minutes to get as many initials as possible of people in this class who fit the descriptions given below. Try and get a different person for each item.

________Someone who speaks a foreign language.	________Someone who has the same color hair as you.
________Someone whose birthday is the same month as yours.	________Someone who has camped out or gone backpacking.
________Someone who has traveled to a foreign country. Name of country:	________Someone who has looked at the moon, planets or stars through a telescope.
________Someone who has the same last initial as you.	________Someone who can tell you what is the latitude of your town or city.
________Someone who knows how to send e-mail messages using a computer.	________Someone who can tell you what is the altitude of your town or city.
________Someone who is the same height as you.	________Someone who is wearing the same colors as you are today.
________Someone who knows who is Gaia.	________Someone who was born in a foreign country.
________Someone who can explain what is the main cause of smog.	________Someone who has written a letter to a person in a foreign country such as pen pal.
________Someone who knows when the Fall equinox happens.	________Someone who likes the same music as you.
________Someone who has heard of global warming.	

Figure 6. Finding Out Who We Are, a handout to be used in Activity 1.

2. Explain to your class they are going to be involved in the Global Thinking Project, and they will be using a computer-based telecommunications systems to study global environmental problems with students not only in other schools in their region, but in other countries as well. During this school year, schools from these countries will be part of the project:

- Australia
- New Zealand
- Russia
- Spain
- United Kingdom
- United States

You might point out the computer that is in your room that will be used for telecommunications, and use a map of the world to point out the location of the countries involved in the project.

3. Ask the class to explain what is an environmental problem, and to name some examples. Write student responses on a large sheet of paper, and hang the results on a wall in the class.

4. Give each student in the class a season card. You should make copies and distribute them in such a way that when students form teams of four, each of the seasons will be represented in each team. Tell the students to move around the room and find three other people who have different seasons. When a group is formed, sit close to each other in a small circle, or at a table. When the students have formed their groups, tell them to do the following:

You each have one minute to introduce your selves to each other in your small group. Tell your name, and then tell your group what experiences you have had or what you know about environmental problems. The person who is the Fall season in each group should keep time, and the person who is Winter should jot down what each person says.

5. Ask the person who was Summer in each group to give a one minute report to the whole class describing what their team discussed. Record key ideas on a large sheet of chart paper and hang the results on a wall in the class.

6. Tell the class that the focus of their work will be global thinking. You might show the students the cover of the Global Thinking Teacher's Resource Guide, and point to the picture of the planet Earth. Then you might read this quote by Yuri Artyukhin, a Russian cosmonaut, who said this during one of his voyages in space:

It isn't important in which sea or lake you observe a slick of pollution, or in the forests of which country a fire breaks out, or on which continent a hurricane arises. You are standing guard over the whole of our Earth.

Yuir Artyukhin
Russian cosmonaut

Неважно, в каком озере или море ты обнаружил очаги загрязнения или в лесах какой страны увидел возникшие очаги пожаров, над каким континентом зарождается ураган. Ты охраняешь всю свою Землю.

Юрий Артюхин

7. Give each team the task of brainstorming what they think might answer this question: What, in your opinion, is global thinking? Tell the students to write at least five different ideas on a sheet of paper. Then ask them to summarize these ideas into a single statement. Tell them they have ten minutes to complete their task. Make sure you use these roles, and have the students record their data on a large sheet of paper as shown.

Student Roles	Data Sheet
Fall Equinox: Keeps time Summer Solstice: Records information on chart paper Winter Solstice: Reads the final statement to the class Spring Equinox: Makes sure the team understands the task	What is global thinking?

8. When the teams are completed ask the person who was Winter to read their team's statement to the class. The statements should be hung on a wall in the class.

9. To acknowledge the importance of global thinking in your class, tell the students that you want them to work with you to create a Global Thinking Bulletin Board. Explain that each class is creating a bulletin board in their classroom that will contain information relevant to the study of global thinking, the names and locations of participating schools, as well as up-to-date e-mail and conference messages.

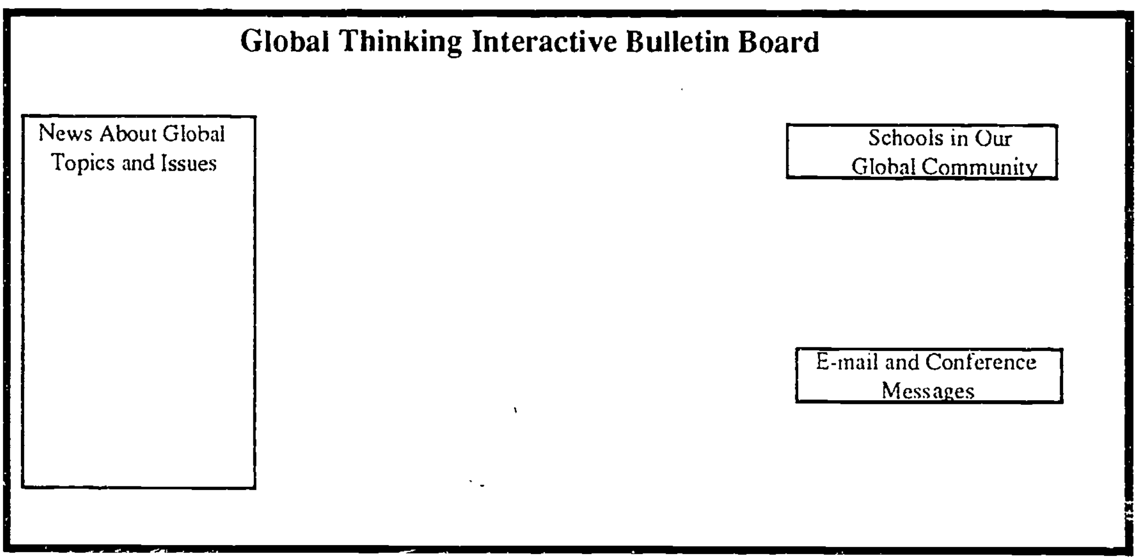


Figure 7. Template for the Global Thinking Bulletin Board

10. Ask the students what they think should be included in such a bulletin board: They will suggest a variety of items including: world map, newspaper and magazine articles about global problems, information about collaborating schools (such as pictures of the

school and participating classes). Let students take responsibility (with your facilitation) for creating the Global Thinking Bulletin Board.

11. As a follow-up, ask each student to look through the local newspaper and bring in an article or story that has something to do with global thinking. Students should post the article on the Global Thinking Bulletin Board. It is important to keep this information current. You might assign groups of students the responsibility for keeping this section of the bulletin board up-to-date.

Cooperative Team Building — Activity 2

Problem on the Way to Mars

In this activity you are going to have your students imagine that they are part of an international space exploration team in the process of using a moonport in preparation for a human flight to the planet Mars. As space explorers, they frequently fly from a space station orbiting the moon to the surface of the moon where the moonport is located.

On their most recent flight to the moonport, their space vehicle crashes on the moon about 120 kilometers from the moonport. The rough landing ruined their space vehicle, except for 15 items (listed below, and shown as cards in Figure 8). Survival of their team depends upon reaching the moonport as soon as possible.

Items: box of matches, food concentrate, 50 feet of nylon rope, parachute silk, solar-powered heating unit, two .45 caliber pistols, stellar map of the moon's constellations, self-inflated raft, magnetic compass, five gallons of water, signal flares, first-aid kit, solar-powered FM walkie-talkie, one case of powdered milk, and two tanks of oxygen.

In order to get to the moonport, they must pick the most important items for the 120 kilometer trip. Their task is to rank the 15 items from most important to least important.

Objectives:

• to engage students in cooperative problems solving task.
• to practice using student cooperative roles of communicator, tracker, checker, materials manager.
• to take turns while working as a team so that each member of the team contributes to the solution of the problem

Materials

One set of cards for each team (Figure 10), large sheet of newsprint paper, marking pen, set of student role cards (Figure 5).[3]

[3] For those of you that are interested, you can obtain *free curriculum materials* on the Marsville Project: a project in which students collaborate to design a human settlement on Mars. Write: Challenger Center, 1055 North Fairfax Street, Suite 100, Alexandria, VA 22314 USA.

Procedure

1. Divide the class into four member teams. You might want to use the same teams as you used in Activity 1, or you might form new teams. If you form new teams, use a random method to do so such as counting off. Once the teams have been formed, have members count off from one to four. Assign the roles as follows:

1. Communicator
2. Tracker
3. Checker
4. Materials manager

Distribute the role cards to each team, and review briefly the function of each role. Make sure each student knows his or her function.

2. Explain to students the task. You might say this while you show a picture of the graphic organizer shown in Figure 8:

I want each team to rank order the items shown on the deck of cards from most important to least important. To do this, place the cards face-down on a large sheet of paper. Draw a line on the paper, and label one end "most important," and the other end "least important." The checker should draw the first card and show it to the group. This person should decide where on the line they think the item should be placed. As this is done, the team should reach consensus on the item's placement along the line "least important" to "most important." Go round in a circle repeating the process until all the cards have been placed on the line.

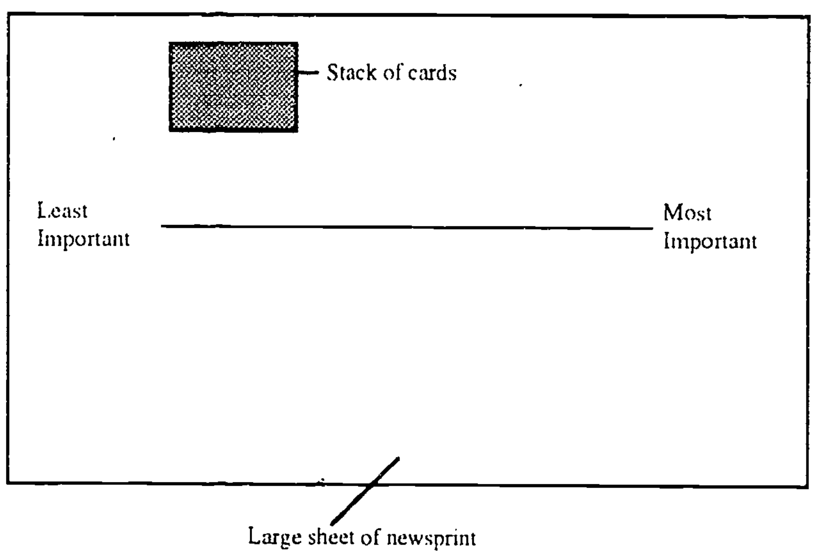


Figure 8. Graphic Organizer for Problem on the Way to Mars Activity

3. Before the materials manager picks up the deck of cards, newsprint and marking pens, tell the checker to discuss the activity in the small team and make sure everyone knows what they are to do. When each signals they understand, they can send their materials manager to pick up the materials.

4. Give the teams a few minutes to draw and label the line (the tracker should do this). Then tell the teams to proceed with the activity. Give them no more than 15 minutes.

5. When the teams have completed their work, have one person from each team (choose the communicator) to write the names of the five highest rated items on a class chart like the one shown below. Give each team an opportunity to explain the rationale for their team's ranking.

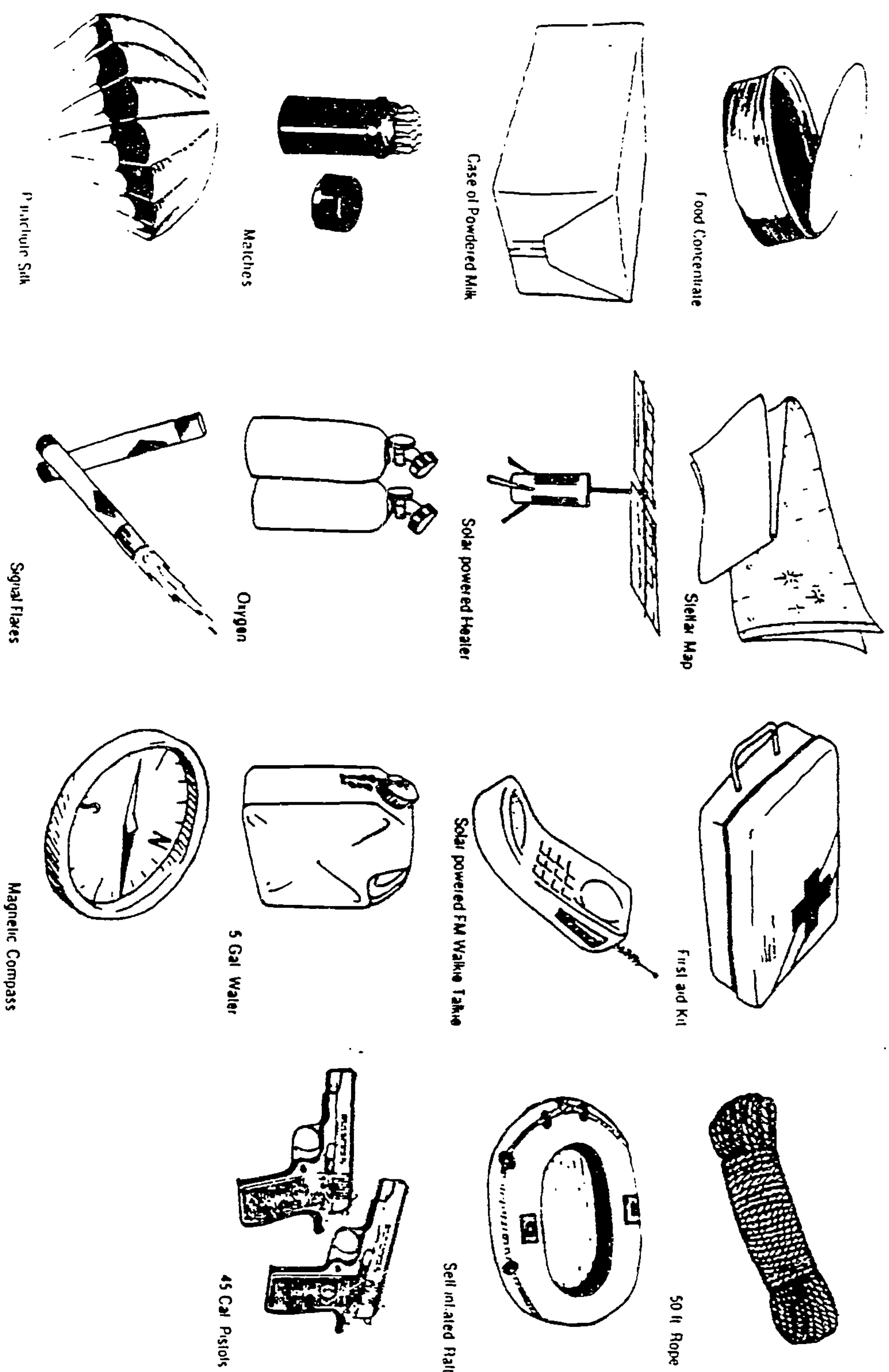
Student Teams	Item #1	Item #2	Item #3	Item #4	Item #5

Figure 9. Class Chart for Activity 2.

6. Debrief the activity by focusing on the how the team's worked together as cooperative groups. Ask the students in each team to discuss and write one set of responses per team to each of the following questions:

a. To what extent did all members of the team participate in the activity.
b. To what extent did members listen to each other.
c. What are three things your team can do to increase the participation of group members.

Figure 10. Cards for the Activity, "Problem on the Way to Mars"



38

39

Is the Earth's Climate Changing?

Objectives

- to work as a team to interpret temperature data shown on graphs
- to make predictions about how temperatures on the Earth have changed in the recent and distant past, and to compare predictions with data.
- to take turns and contribute to the thinking of the group using cooperative learning.

Materials

graph paper, graphs entitled "Average Global Temperatures in the Recent and Distant Past, set of climate change questions.

Procedure

1. Divide your class into the same teams that you formed for Activity 2. However, change roles, so that each students gets a chance to practice a new cooperative learning role.

2. Give each team a sheet of graph paper and ask them to make a prediction about how the temperature of the Earth has changed in the past 100 years. Make a drawing on the overhead or chalkboard to help them. Tell them to draw their prediction as graph of temperature versus time. If you have small slate or white boards, use them for student predictions. After a few minutes, ask each team to show its graph to the class. Now ask the teams to discuss how they think temperature has changed over the past 500,000 years. You can provide another graph, and student teams can make predictions about temperature change over this period of time. Again, have teams show their predictions.

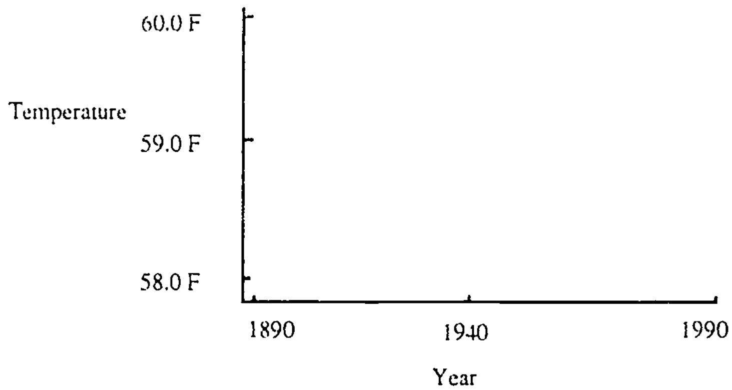


Figure 11. Graph Predicting How Students Think Temeperatures have changed over the past 100 years.

3. Tell the students that they are going to analyze graphs showing temperature changes in the recent and distant past, and compare their predictions to the data. Explain that the materials manager will pick up the graphs, and a set of questions. They are to work together as a team to answer the questions. You might say this to the teams:

When you get the graphs, and the set of questions, give the set of questions to the checker. The checker reads the first questions aloud to the group. The team should discuss the question, and the checker should write the team's answer on the paper. The checker should then pass the paper to another team member. This person should read the question aloud and write the team's answer on the sheet after it has been discussed. Continue passing the paper around in circle until all the questions are answered.

Climate Change Questions

1. What has happened to the temperature of the Earth in the most recent 100 years? How does this compare to your prediction?

2. How much has the temperature changed during the most recent 100 years?

3. How much has the temperature of the Earth changed over the past 450,000 years? How does this data compare with your prediction?

4. During the past 450,000 years, would you say that the Earth has been generally warmer than now, or colder than now?

5. How many warm periods, or "interglacials," have there been in the past 450,000 years?

6. How long has the Earth been in its current "warm" period?

4. When the teams have completed the questions, discuss their answers one question at a time. To do this, have the team members number off from one to four. Write the numbers one to four on separate small sheets of paper. When you are ready to discuss the first question, draw a sheet of paper and read the number aloud (1, 2, 3, or 4). The student with that number from each team should stand, and be ready to answer the first question. Call on one of the students that is standing. You can have the other students give a thumbs up or down for the answer, or call on another students who is standing to compare answers. Continue discussing each question by repeating the process.

5. Debrief the activity by having the teams discuss and write answers to the following questions.

a. What have you heard about climate change (global warming) in the newspaper or on television?

b. Are you concerned about the changes in temperature that some scientists think might happen over the next 50 years? (Some scientists predict a temperature increase as much as 5 F.

c. To what extent did everyone in your group contribute to the analysis of the graphs?

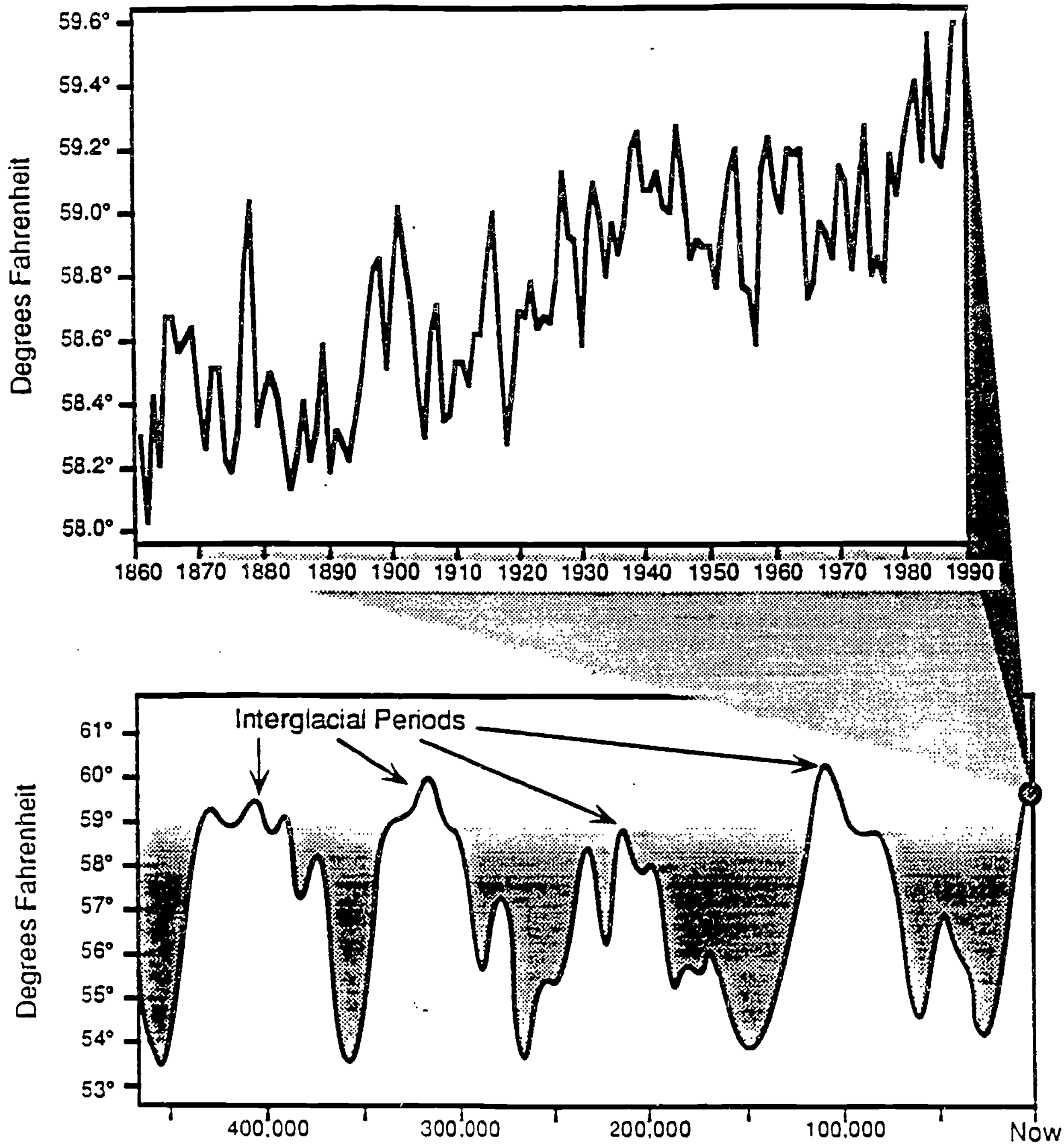
d. What does your team do well when it works together?

e. What could your team do to improve it ability to work together?

Congratulations. You have finished the section on cooperative learning. You are now ready to move on to telecommunications, and link yourself with the world!

Average Global Temperatures in the Recent and Distant Past

Average Temperature Of The Atmosphere In The Most Recent 130 Years
This graph is based on temperature measurements from land and island stations, as analyzed by Jones and Wigley, 1988, at the Climate Research Unit, East Anglia, England. (*Global Warming*, by Stephen H. Schneider, page 85)



Average Surface Temperature Of The Ocean In The Most Recent 450,000 Years
This graph is based on a variety of geological techniques as compiled by the National Academy of Sciences. (*Future Weather and The Greenhouse Effect*, by John Gribben, page 31)

CHAPTER 3

Using Telecommunications to Collaborate Globally

From Space I saw Earth---indescribably beautiful with the scars of national boundaries gone.

Muhammad Ahmad Faris
Syrian Astronaut

من الفضاء رأيت الأرض جميلة رائعة وتلاشت الحدود بين البلدان.

محمد أحمد فارس
سوريا

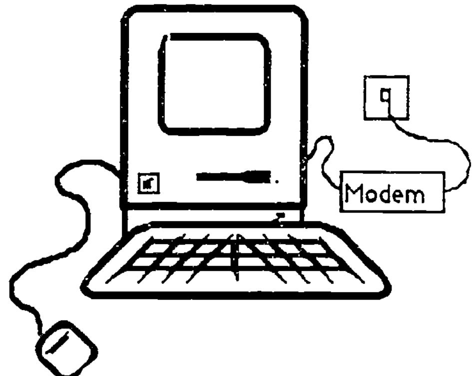
One of your roles as a teacher in the Global Thinking Project is to create a classroom environment that is conducive to communication among students in your class with students not only in other classes in your country but with students around the world. A way to do this is to establish a telecommunications hub in your room that will enable kids in your class to link with their peers. With a computer, a modem and telephone line your students will be connected globally. This chapter will explain how to use telecommunications to achieve connectivity. A tutorial to take you through the process of using telecommunications is followed by several lessons that introduce your students to how telecommunications are used in the Global Thinking Project.

A Global Classroom

Elena Antonenkova and Sara Crim are science teachers in schools 91, Moscow, Russia and Chattanooga Valley Middle, Northwest, Georgia, respectively. Their classrooms are equipped with a Macintosh computer, a modem connected to a telephone line, and a printer. Their schools have telecommunications accounts on the GlasNet and EcoNet systems, enabling them to connect with schools not only in their own country, but all around the globe.

Like these teachers, you and your students will be participating in the Global Thinking Project. One of your first responsibilities is to establish a global classroom, one in which you are networked to schools around the world. To establish a global classroom, you should have the following in your room:

- Microcomputer
- Modem connected to a telephone line
- Printer
- Telecommunications software
- Large map of the world
- Globes
- An account on a telecommunications network



You should try and establish a telecommunications center in your classroom. The computer, modem and printer should be set up in the telecommunications center on a table around which three or four students can sit. A bulletin board containing a map of the world with adequate space to post messages retrieved from your telecommunications system should be prepared and located nearby. Refer to Activity 1 in Chapter 2 for details about creating a global thinking bulletin board. Magazines, journals, books and general resources on environmental science and computers should be available in the center as well. You should also start collecting software related to global and environmental problems and make it available to your students.

Taking the time to establish the telecommunications center will be well worth the effort. Students will know that it because of your efforts in establishing the center that they are able to connect with peers around the world. And that is a compelling idea.

Establishing an Account on an IGC Network

To participate in the Global Thinking Project, your school should have an account on one of the following telecommunications systems, each of which is part of the Institute for Global Communications (IGC):

- EcoNet (USA)
- GlasNet (Russia)
- GreenNet (Europe)
- Pegasus (Australia)

EcoNet: Contact the Institute for Global Communications, 18 DeBoom Street, San Francisco, California 94107. ph: 415/442-0220, fax: 415/546-1794, Email: support

GlasNet: Contact GlasNet, Ulitsa Yaroslovaskaya 8, Korpus 3, Komnata 111, 129164 Moscow, RUSSIA, Phone: +7 (095) 217-6173, Email: support@glas.apc.org

GreenNet, 23 Bevenden Street, London N1 6BH, ENGLAND, Phone: +44 (71) 608-3040, Fax: +44 (71) 253-0801, Email: support@gn.apc.org

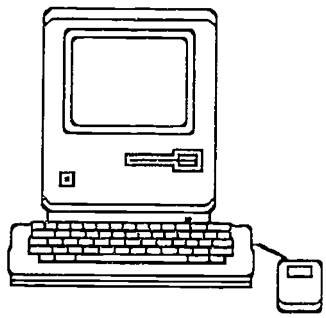
Pegasus Networks, PO Box 424, The Epicentre, B order Street, Byron Bay 2481, New South Wales, AUSTRALIA, Phone +61 (66) 856789, Fax: +61 (66) 856962, Email: support@apc.org

USING THE INSTITUTE FOR GLOBAL COMMUNICATIONS (IGC) NETWORKS IN THE GLOBAL THINKING PROJECT

The Intitute for Global Communications (IGC) provides the Global Thinking Project the electronic means to bring schools around the globe together. Through this network, and other associated affiliated networks world-wide, your account on an IGC account makes you part of a global system of telecommunications. American teachers connected to EcoNet will join with teachers on GlasNet, GreenNet, and Pegasus to comprise the Global Thinking Project.

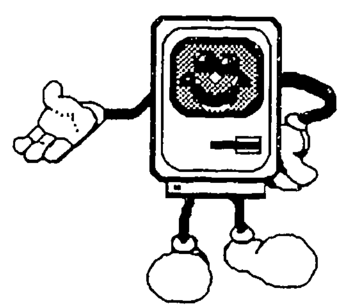
Your participation in the Global Thinking Project and your network accounts on EcoNet, GlasNet, Pegasus, or GreenNet enables you to participate in a number of telecommunications activities including:

• **Electronic Mail**: Using the Network's (m)ail command, you and your students can exchange messages, reports, and data with teachers and students around the world who are participating in the Global Thinking Project. In particular, you will use electronic mail to communicate with members of your Global Community.



• **Electronic Conferences**: The Global Thinking Project has several conferences (electronic bulletin boards) designed for you and your students to send, read and respond to messages on the Global Thinking Project. One conference (gtp.earthconf) will be used to post all messages of the project, thereby providing an archive for all schools: another is a conference for students to ask scientists questions, and a third is to support and help the Global Thinking teachers.

• **Electronic Interaction with Gaia**: Gaia is a virtual character developed for the Global Thinking Project to interact with you and your students. Gaia (the name of the Greek goddess of the Earth), is the name given to the hypothesis by James Lovelock and Lynn Margolis that suggests that living things maintain the chemical balance of air, seas and soil to ensure their existence.



GAIA

GLOBAL COMMUNITIES OF PRACTICE

The schools that are members of the Global Thinking Project are organized into several groups of schools world-wide, called *Global Communities*. A *Global Community* is comprised of about ten schools selected to give each community diversity in terms of geography, climatic zones, hemispheres, and cultures.

Phase I Global Communities

During Phase I of the Global Thinking Project. your school will be assigned to a Global Community. During Phase I, your global partners will work together on Projects Hello, Clean Air and Global Thinking. The time period will be approximately three months (September through early December). Duri:g this time whenever you send email, you will be sent it to each member of your community, as well as to the main Global Thinking Project electronic conference, *gtp.earthconf*. Email is a more personal form of communication, and it will be more meaningful to your students. The *gtp.earthconf* will provide a record of all communications in the Global Thinking Project, and will be an important resource to all the communities.

One of thefirst things your class will do when it is assigned to a Global Community is to send a packet of information to each of the schools in your Global Community. Details of the contents of packet are located in Project Hello (Activity 1). To give your students a sense of community, you should set up a map of the world, and as information comes in from the schools in your Global Community, you can have students display as much of it in the area of the world map.

Phase II and III Global Communities

During Phase II you will select one project to work on during a two and half month period. From mid-December through February, GTP schools will select and then work on one project of their choice. Global Communities during Phase II will be based on the content of the projects selected as follows:

- Solid Waste Community
- Ozone Community
- Water Watch Community

In future years, other commnities will be formed as new projects are developed.

In late November you will be asked which community you wish to join. Project Headquarters will inform all schools of the composition of each of the communities. Thus, during Phase II, you might be working with some new schools.

During Phase III. the focus of the Global Thinking Project will turn to Project Earthmonth. Project Earthmonth is an action-taking project designed to encourage each school to work on a "project" that encourages "local as well as global action." Communities that were formed for Phase II will continue to function into Phase III.

ALICE NETWORK SOFTWARE

The Global Thinking Project uses the The ALICE Network Software. an integrated computer application designed to improve the use of telecommunications for collaborative investigations. This software incorporates word processing, data analysis and graphing, mapping, and telecommunications tools. It may be used on two platforms: the Macintosh computer and the IBM PC or compatible with Microsoft Windows. The use of the ALICE Network Software is restricted by the licensing agreement which stipulates that the software can only be used on the computers used in the Global Thinking Project. and for GTP activities.

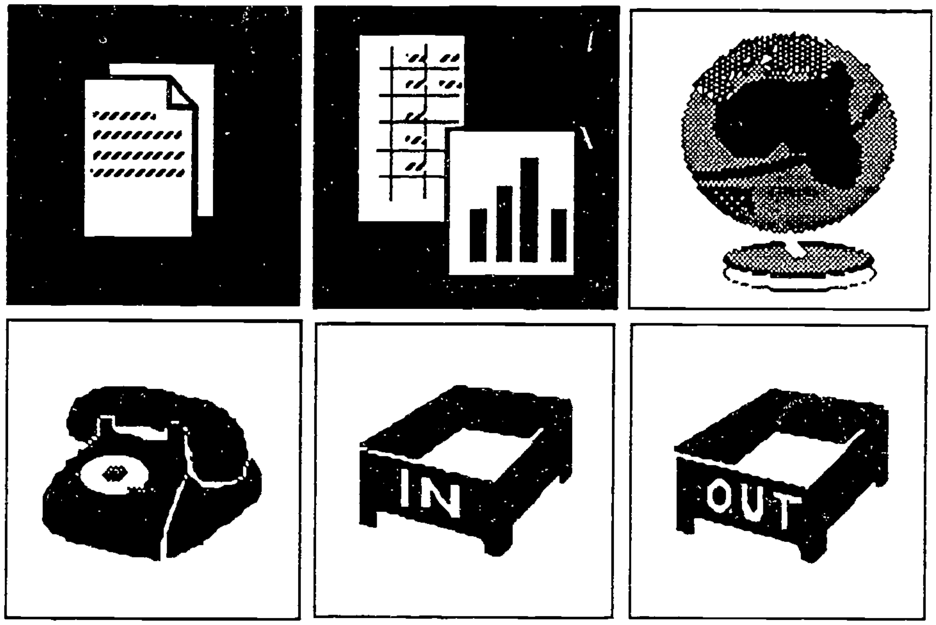


Figure 1. The Desktop of the ALICE Network Software. You and your students will use ALICE to send reports, enter, analyze and graph data, map and view data geographically, connect to the IGC Network to send and receive text and data.

You can refer to the detailed ALICE Reference as you need more help with using the system. However, the Global Thinking Project provides training for all Global Thinking Project teachers. After some initial training, you may only have to refer to the ALICE Network Software Quick Reference (found as a separate section at the end of this Chapter).

The ALICE Network Software has been programmed for users of the IGC Telecommunications system. The software will enable you to do all of your work offline, including the preparation of reports, data tables, and graphs. When you are ready send mail, you will use the Telecommuunications tool to conduct either an automatic network session (all outgoing and incoming mail is uploaded and downloaded automatically), or a manual session in which you use a local Telnet phone number to log on to the IGC system. Manual sessions require that you become familiar with the protocols of the IGC Telecommunications system. A detailed tutorial keyed to the Global Thinking Project to help you with manual sessions follows this section. You also will receive the User's Manual from the Institute for Global Communications to help you with using IGC.

TELECOMMUNICATIONS TUTORIAL

Although you will receive a very extensive User's Manual when your account has been established, the following material should be useful to you to get you started, and tailor your work with the Global Thinking Project. This tutorial is designed for you. After you use it and become comfortable using the telecommunications system, you can use this material when you teach your students to use the system.

Objectives

By using this tutorial you and your students will be able to:

1. Log in to EcoNet, GlasNet, GreenNet, or Pegasus.
2. Read and respond to electronic mail.
3. Write new electronic mail.
4. Find the Global Thinking electronic conferences on EcoNet.
5. Write to an electronic conference.
6. Create a personal list of conferences that you regularly visit.
7. Download electronic mail and conference messages
8. Upload and send mail and conference messages.
9. Communicate with Gaia.

Logging In to IGC

You should refer to the Institute for Global Communications User's Guide, and IGC Login Information sheet that you received when your account was established. There is a section in the User's Guide to show you how to log in.

You should have the ALICE Network Software loaded on your computer. Here are the steps you should follow to Log In to IGC manually.

```
 File  Edit  Connection                                              2:46
                              Network Access

In order to see letters you are typing, the modem must be connected and turned o

Modem Port is set to N81  1200 bps
atdt5230834

CONNECT 1200

TELENET
404 210A

TERMINAL=

@c igc

IGC CONNECTED

   login: (? for help): jhassard
Password: (? for help): xxxxxxx
Terminal = generic (hit <RETURN> or enter new terminal type):
*******Welcome to the Global Thinking Project*******

As the Global Thinking Project year comes to a close, we would
```

Figure 2 : Manual Session Using the ALICE Network Software.

- Connect your computer to the modem and phone line
- Install the Alice Network Software

- Set up your communications software using the Log In information you received from EcoNet
- To connect to the network manually:
  1. Select Manual Session from the Network command on the ALICE Network Software Desktop.

  2. In the Window titled Network Access, type **ATDT** followed by your local access phone number to IGC and press return (See the Figure 1).

  3. Wait for the CONNECT message to appear.
     If you see CONNECT 1200,. press Return 3 times
     If you see CONNECT 2400, type @ and press Return twice
     If you see Connect 9600, type **@D** and press Return twice

  4. Wait for the @ prompt to appear. Type **c igc** and Return.

  5. Wait for the login prompt. Type your userid.

  6. Wait for the passwork prompt. Type your password.

  7. At the next prompt, hit Return.

If all goes well, you will get the "Welcome to the Global Thinking Project" banner, followed by this salutation:

```
Welcome to the Netwo   For help, type "?"
Network commands:

   (c)onf
   (h)elp
   (m)ail
   (s)et up
   (u)sers
   bye
```

Electronic Mail

Electronic mail will enable you to send messages to, or receive them from other participants in the Global Thinking Project.

Everytime you log in to EcoNet, the Network automatically checks to see if you have new mail since you last logged in. If you have received mail, here is what you will see when you log in:

```
Welcome to the Network. For help, type "?"

You have new mail messages

   (c)onf
   (h)elp
   (m)ail
   (s)et up
   (users
```

To read your mail, select (m)ail from the main menu. When you hit <RETURN> you will see this screen:

```
Reading folder: incoming....3 messages 1 new
Type 'u' for next unread message, '?' for command summary, 'h' for more help.
```

In the example given, you have 3 messages (1 new) in your mail folder. The new message arrived since you last logged in. At this point you can:

Type	And Get This Outcome
u	read your first (u)nread message;
i	type i to provide an (i)ndex of all the messages in your incoming mail folder. Unread messages will be marked with an asterisk (*)
r*	(r)ead all (*) messages in your folder
i:u	provides an (i)ndex of your unread messages only.

Reading and Responding to Mail

To see your unread messages, you can type the number of the message or u for "unread," followed by <RETURN>

```
Mail? u   <RETURN>
Message 3 (15 lines)
From gaia1 Thu Sept 3  18:42 PDT 1992
To: auser
Subject: Global Thinking Project

I understand that you and your students have joined the Global Thinking Project and will
be collaborating with other students and teachers about global problems.

Let me hear from you and what some of your concerns are with regard to planet Earth.

Best regards,

gaia

-- Hit (RETURN> for more --
Mail?
```

(note: if the message is too long you will not be able to see it all on one screen. To continue reading the message simply press <RETURN>

To (w)rite a (r)esponse to this letter, type (w)rite at the Mail? prompt and hit <RETURN>

```
Mail? w <RETURN>

Do you want : (r)eply message  (n)ew message   (s)end copy? r
Reply to (s)ender  or (e)veryone in list? s
To: gaia1
Subject: RE:  Global Thinking Project

Hit <RETURN> or <ENTER> to type in a message, or 'u' to (u)pload a file: <RETURN>
Begin typing, end with a line containing only a period.
Dear Gaia, <RETURN>
<RETURN>
My class is very interested in your opinion regarding ozone depletion and air pollution, as
well as what kids can do to have a voice in improving the environment. <RETURN>
<RETURN>
Sincerely, <RETURN>
<RETURN>
        A. User <RETURN>
. <RETURN.
Message sent.

Mail?
```

Writing New Mail

To write (n)ew mail to someone in the Global Thinking Project, you simply use the (w)rite command from the Mail? prompt.

```
Mail? w <RETURN>
```

At this point you will be given three choices:

(r)eply	you can respond to mail you read
(n)ew	you can send a new message to someone
(s)end copy	you can send a copy of the last piece of mail you read

To write a new message, select (n)ew, press <RETURN>. You will see the "To:" prompt, where you will enter the person's account name. Then you will be prompted to enter the "Subject:"

```
Mail? w <RETURN>
Do you want (r)eply (n)ew message (s)end copy? n <RETURN>
To: globalschool <RETURN>
Subject: Collaborate On Air Pollution? <RETURN>

Note: at this point you will be prompted to type your message, and end by typing a period
in an empty line followed by <RETURN>
```

Since you will be writing mail to users in the Australia, Russia, Spain and the United States (and other countries as they join the project), you should be aware of how to address letters to these various networks. For example, for an EcoNet (or Pegasus, or GreenNet) user to write to a GlasNet account, the address would look like this:

To: glas:auser

To write to a GreenNet account, the address would be:

To:gn:auser

To write to a Pegasus account, the address would be:

To: peg:auser

Writing from GlasNet, GreenNet, or Pegasus to Econet, the address would be:

To:igc:auser

HELP: *If you have problems, refer to your Network User's Manual.*

Finding Electronic Conferences

There are several Global Thinking electronic conferences that you will use to interact with students and teachers in other schools, with scientists, as well as with the Global Thinking Project headquarters at Georgia State University.

The Global Thinking conferences include:

• **gtp.earthconf**: This conference will be used by teachers and students to post messages about the work being done on projects and activities. It will be the principle bulletin board used by participating schools. Although you will be sending email to all members of your Global Community, you will also send a copy to the *gtp.earthconf*. This will provide the GTP with a record of all communications, and will enable each community to access the work of other Global Communities.

• **gtp.scientist:** This conference is a place for students and teachers to ask questions about the content of the projects. Scientists will respond to any questions and inquiries.

• **gtp.teachers**: This conference is designed to facilitate communication among the teachers and the project. It is there to support teachers using the project curriculum. Check the conference for announcements about the Project's activities, and use it as a vehicle to share ideas about Global Thinking.

• **gtp.solidwaste**: This conference will be used by schools that participate in Project Solid Waste.

• **gtp.waterwatch**: This conference will be used by schools that participate in Project Water Watch.

• **gtp.ozone**: This conference will be used by schools that participate in Project Ozone.

To find and access a conference, select (c)onference from the main menu. To visit a conference type its name at the "Conf?" prompt.

```
Conf? gtp.earthconf <enter>

Visiting gtp.earthconf....2 unread topics, 2 unread responses
'u' to see next unread item, '?' for command summary, 'h' for more help
```

If you want to see the 'index' or listing of the topics for the gtp.earthconf, then all you need to do is to type i (for index). When you do this you will see this screen:

gtp.earthconf

2/19/92	1 Purpose of This Conference	Support
3/20/92	2 Global Thinking School Profiles	jhassard

Note: depending when you log in, gtp.earthconf will most likely have many other topics created by students and teachers.

Writing to a Conference. You must be in a conference to write to it. We'll use the example of writing to gtp.earthconf to help you understand this function. Acess the gtp.earthconf by typing its name from the conference mode. Then follow the prompts in the box below.

1. Type w(rite) at the Conf? prompt.
2. Select (n)ew message
3. Select (c)onferencing
4. Hit RETURN
5. Type your message
6. End the message by typing a period in an empty line
7. When you type the period, you will be prompted to send the text or edit. Hit RETURN
8. You will be prompted to Enter title (of your message). Type the topic title and then hit RETURN

Writing to gtp.earthconf

Conf? w
(r)eply message (n)ew message (s)end copy (f)orward copy (? for help): n
Do you want (c)onferencing or (m)ail (?for help): c
Starting up editor
Hit <RETURN> to type in a message, or 'u' to (u)pload a file: <RETURN>
Begin typing, end with a line containing only a period.

Type your message here.

. (period in empty line)

Hit <RETURN> or <ENTER> to send text, 'e' to edit. <RETURN>

Enter title ________________________________.

Hit RETURN
(message will be sent and posted in gtp.earthconf. You can check to see it got there by typing 'i' at the Conf? prompt.)

Creating a Personal List of Conferences

You can create a personal list of conferences that you regularly visit. Everytime you log in, the Network automatically checks to see if you have new conference entries since you last logged in. If there are new conference entries, here is what you will see when you log in:

Welcome to the Network. For help, type "?"

You have new mail messages

You have new conference entries in gtp.earthconf, gtp.scientist, gtp.teachers

(c)onf
(h)elp
(m)ail
(s)et up
(users

To systematically, and easily check your personal list of conferences, access the (c)onference mode from the main menu, and then type (v)isit. Each conference in your list will appear on your screen. If there are new entries, you will be prompted to check the (u)n read topics.

To create your personal list of conferences, access the (c)onference mode from the main menu, and then type (m)aintenance. You can look at your list of conferences by typing (l)ist. From here you will be able to add or delete conferences and reorder your list.

Conf? m

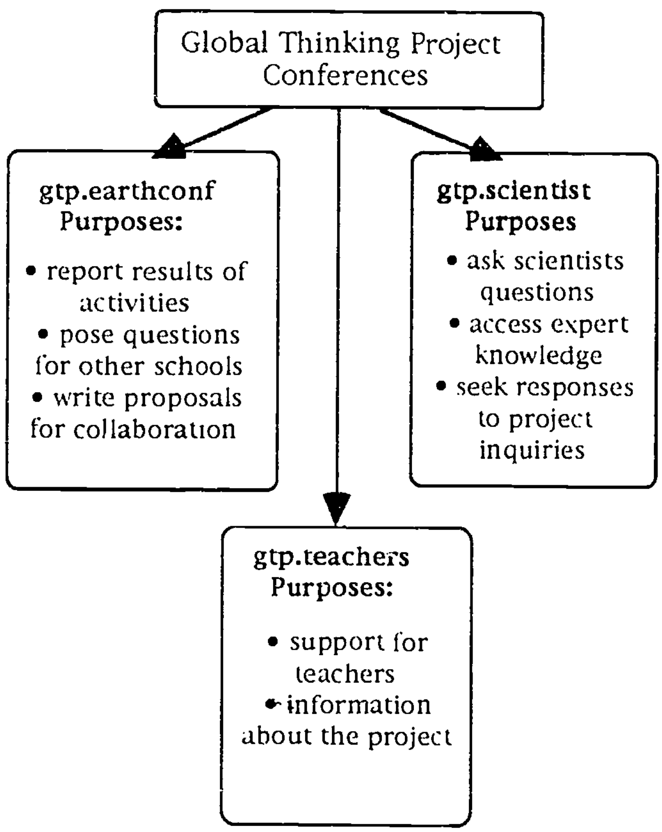
Standard conferences: (a)dd (d)elete (l)ist (r)eorder (? for help): l

The conferences in your visit list are:

1. gtp.earthconf
2. gtp.scientist
3. gtp.teachers

Standard conferences (a)dd (d)elete (l)ist (r)eorder (? for help):

Note: when you first log in and start working on the Global Thinking Project, you will have to add the Global Thinking conferences to your list. EcoNet has probably listed a few conferences for you when you signed up. You can keep these, or delete them from your list.



Downloading

Downloading enables you to transfer information off the network directly to your computer. This will save you money because you will be able to read and print the messages out while you work "off-line."

Downloading Mail. Go to your mail folder, and type (c)apture. You will be prompted to type (d)ownload), and then you will be asked to enter the message number.

```
Mail? c
Do you want to  (d)ownload message or switch (p)aging On/Off? d
Enter Message number: 1
702 bytes to download
Protocol: (a)scii-text  (k)ermit  (x)modem  (y)modem (z)modem (f)tp (? for help) z
Enter filename to store message in: Letter from gaia
Please instruct Your modem software to RECEIVE using zmodem soon.
   Hit <RETURN> when done.
**
Received file: letterfromgaia (1K in 0:11 sec, 63cps)
Delete original message(s) (y/n)?n
```

Downloading Conference Topics. Downloading conference topics means you must be in the conference. Access the conference gtp.earthconf from the Conf? prompt. To download type (c)apture. You will then be prompted to complete the downloading process.

```
Conf? gtp.earthconf

Visiting gtp.earthconf....1 unread topic, 0 unread responses
'u' to se next unread item, '?' for command summary, 'h' for more help
Conf? c

Switch (p)aging On/Off, or perform (d)ownload (? for help): d
Downoad current (m)essage, (t)opic, or (u)read msgs (? for help): t
What is the topic number?: 1

1096 bytes to download.
Protocol: (a)scii-text  (k)ermit  (x)modem  (y)modem  (z)modem (f)tp (? for help):z
Enter filename to store message in : purpose of this conference
Please instruct YOUR modem software to RECEIVE using zmodem soon.
   Hit <RETURN> when done
**
Received file: purposeofconferecne (2K in 0.12 sec, 91 cps)
```

When a message is being downloaded, your computer will acknowledge the downloading process. Figure 2 shows the "Receive File Progress" screen on a Macintosh computer using the ALICE Network Software.

```
 File  Edit  Connection                                              8/
                              Network Access
Aug 17   8 future billing and thanks                 48    northheights
Aug 17   9 Re:  Wednesday                            13    wcsc
Aug 17  10 Chapter 1 proposal                        93    wcsc
Aug 17  11 Re:  gtp.* conferences                    24    confadmin
Aug 18  12 Your FAX Request (Ref # 88398)            14    steve
Aug 18  13 Re:  gtp.* conferences                    17    confadmin
Aug 19  14 global thinking project                   12    salemhs
Aug 19  15*New School Year                           38    jhassard

Mail? c
Do you want to (d)ownload message or switch (p)aging On/Off? d
Enter message number: 1

3680 bytes to download.
Protocol: (a)scii-text (k)ermit (x)modem (y)modem (z)modem (f)tp(? for help): z
Enter filename to store message in: gtp
Please instruct YOUR modem software to RECEIVE using zmodem soon.
  Hit <RETURN> when done.
rz
**B00000000000000

Starting Transfer ...
. 13% . 27% . 41% . 55% . 69% . 83% . 97% . 100%
Ending Transfer ...
```

Figure 2 Screen Showing Progress of a File Being Downloaded Using the ALICE Network Software

When you go "off-line" you can use the ALICE Network Software to open the files you have downloaded to read and print.

Uploading and Sending Files

Uploading is a function in which you can prepare letters and reports "off line" (thereby saving you network connect time and money). Prior to going "on line" you and your students can prepare letters and reports which can be sent to individuals using the mail mode, or to a conference using the conference mode.

We'll show an example of sending a file from the mail mode. Here are the steps:

1. Prepare your document (letter) off line.
2. Connect with the network.
3. Choose the mail mode.

4. Type (w)rite, and at the next prompt choose (n)ew.
5. Address the letter to the user it is to be sent.
6. Give the letter a title in the Subject line.
7. At the next prompt, type (u) to upload a file.
8. Choose a protocol: Usually (x)modem will work (check your communications software if you have a problem at this step).
9. Instruct your modem to send the file. In the case of ALICE, you would select Send File.
10. Find the file to be sent from your hard disk, and transmit the file.

The screen will show the following when uploading a file.

```
Mail? w
Do you want: (r)eply message (n)ew message (s)end copy? n
To: auser
Subject: Results of air quality research

Hit <RETURN> or <ENTER> to type in a message or 'u' to (u)pload a file: u
Protocol: (a)scii--text (k)ermit (x)modem (y)modem (z)modem (f)tp )? for help):x
--------------------------------------------------------------------------------
Please instruct YOUR modem software to SEND or TRANSMIT using XMODEM
  Hit <RETURN> or <ENTER> when done.

(Note: this point you will have to instruct the computer to send the file. To do this, please check the manual that came with your communications software. This is not difficult, but you will have to check it out. Check the manual's index for 'uploading files.')

When the file is sent you will see this message:

Sent File: Results of air quality research (3K in 0.53 sec, 50 cps)
2688 characters received.
File contains non---ascii--text characters
  (first one is @)
Convert to (a)scii--text or (b)inary (? for help): a
Do you want to edit the uploaded file (y/n/q)? n
cc:
Message sent.
```

Uploading a file to a conference is no different than sending uploading to mail. Prepare your messages "off line" and then visit the conference to which you want to upload files. Follow the procedures outlined above.

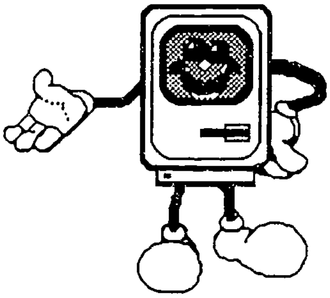
Communicating With Gaia

The Global Thinking Project is a network of schools in different countries that have agreed to work together to engage students in the exploration of global problems and issues. In addition to the network of schools, there is an electronic character called GAIA who was created to unify the participants by interacting with them.

Gaia is a virtual character and will from time-to-time send messages to individual schools, as well as read and react to topics in the Global Thinking electronic conferences. Here are some of the characteristics of this Gaian character:

Gaia

- likes to ask provocative questions
- ponders, reflects, encourages and facilitates actions on Global Thinking projects
- nurtures and provides hope
- provides a vision about the integrity of the planet Earth
- helps kids make their own connections
- broadens horizons to the global level
- shares excitement about the project
- sometimes tells secrets
- sometimes provides answers to questions, but very likely will ask further questions



GAIA

Figure 3. Gaia: a virtual character and messenger of the Global Thinking Project

As a teacher, you can use Gaia to help you and your students participate actively in the Global Thinking Project. Gaia is always there, and if you are in doubt about some aspect of a problem, you can contact Gaia at this address:

Gaia's EcoNet address: igc:gaia1

Gaia will be in touch with you!

Review of the Telecommunication Commands

Figure 3 reviews the main commands for mail and conferences. You should make copies of it for posting at the telecommunications center and distribution to student teams.

Mail

Reading Mail
u read next (u)nread message
n read (n)ext message
p read the (p)revious message
5 read message number 5
i show (i)ndex of mail messages
r (r)ead current message
c (c)apture toggel----options:
  d (d)ownload message or
  p toggle (p)age mode

Writing Mail
w (w)rite mail message---options
  r (r)eply to last message
  n (n)ew message
  s (s)end copy of current message

Other Mail Commands
d (d)elete current message
und (und)elete current message
s (s)ave message in folder

FAX
At the "To:" prompt, enter:
fax:<aaa><nnnnnnn> (US, Canada, Mexico)
fax:011<cc><aaa><nnnnnnn> (International) where <cc> is telephone country code, <aaa> is the area code or city code and <nnnnnnn> is the fax number.

Conferences

General Commands
l (l)ist conferences
g (g)o to a conference
v (v)isit your list of regular conference
  Global Thinking Project options:
  gtp.earthconf
  gtp.scientist
  gtp.teachers
q (q)uit from conference mode
h (h)elp system
m (m)aintain personal list of conferences

From Within a Specific Conference
u show next (u)nread topic or response
t show next unread topic
i (i)ndex page of conference topics
\- back up to last seen message
c (c)apture
15 read topic 15
15.2 read the 2nd response to topic 15
x e(x)it conference ---- options
  f (f)orget you read anything this time
  p (p)retent you've read every-thing

Writing Conference Messages
w (w)rite a topic/response or send mail
  n (n)ew topic or new mail
  r (r)esponse to topic via conf or mail
  s (s)end copy of message
d (d)elte a message you just wrote wrote
e (e)dit a message you just wrote

Figure 4. Computer Network Commands

Telecomputing Activities

Just as we provided a few activities to help your students understand cooperative learning, several activities are provided to help your students understand telecomputing.

Planning Chart: Telecomputing Activities

Activity	Title	Telecommunications Alert	Time Allotment
1	Telecomputing:Using the Computer as a Telecommunications Tool	Demonstrate email and conference modes	1 period
2	Introduction to ALICE	Write Report and Send to Network	2 periods

Telecomputing: Using the Computer as a Telecommunications Tool

The focus of this activity is to introduce the computer, modem and printer to the students, and discuss how it will be used as a tool to collaborate with other schools participating in the Global Thinking Project.

Objectives

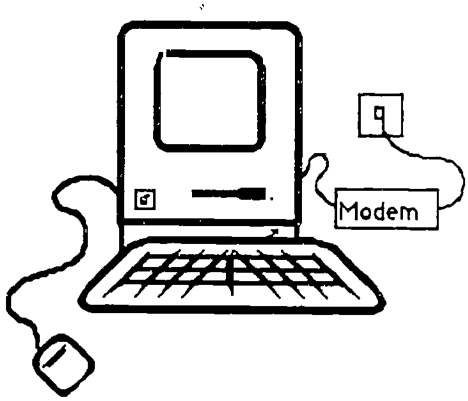
- to explain the use of the IGC telecommunications systems
- to understand the concept of telecomputing
- to describe the computer system that you are using with your class

Materials

computer, modem connected to telephone line, printer, Global Thinking Teacher's Resource Guide

Procedure

1. Point out to the students the computer set up in your classroom, and ask them if they can explain how the computer could be used to communicate with students in another school, not only in their own region, but in another country. Give the students two minutes to turn to a person sitting next to them to describe their concept. When the students have finished describing their ideas to each other, call on a few students to explain their ideas to whole class.



You might also ask your students a series of questions to find out what their prior knowledge and experiences are with computers and telecommunications. Ask: "How many of you..."

- can explain the purpose of a modem
- have used the computer to send messages
- know what is email
- have access to a computer at home
- have taken a computer course

2. Here is some information and a graphic you might use to present a brief lecturette on telecommunications. EcoNet is part of the Institute for Global Communications (IGC),

while GlasNet, GreenNet and Pegasus are part of the Association for Progressive Communications (APC). The IGC and APC are affiliated, and together provide a global communication system linking users all around the world. EcoNet, GreenNet, GlasNet and Pegasus use a network of telephone lines connected to large mainframe computers. Machines that are part of the APC (the IGC is also a member), "talk" to each other everyday, so that all e-mail is immediately routed to e-mail boxes/user accounts and all networked conferences are automatically updated. Figure 4 shows how messages are transmitted among the various networks in the APC system. When you are finished presenting information to the students (no more than 10 minutes), tell the students to work in pairs to summarize the main ideas you presented. You might give them a choice of listing the main ideas, writing a brief description of what is telecommunications, or drawing a diagram that summarizes the concept of telecommunications.

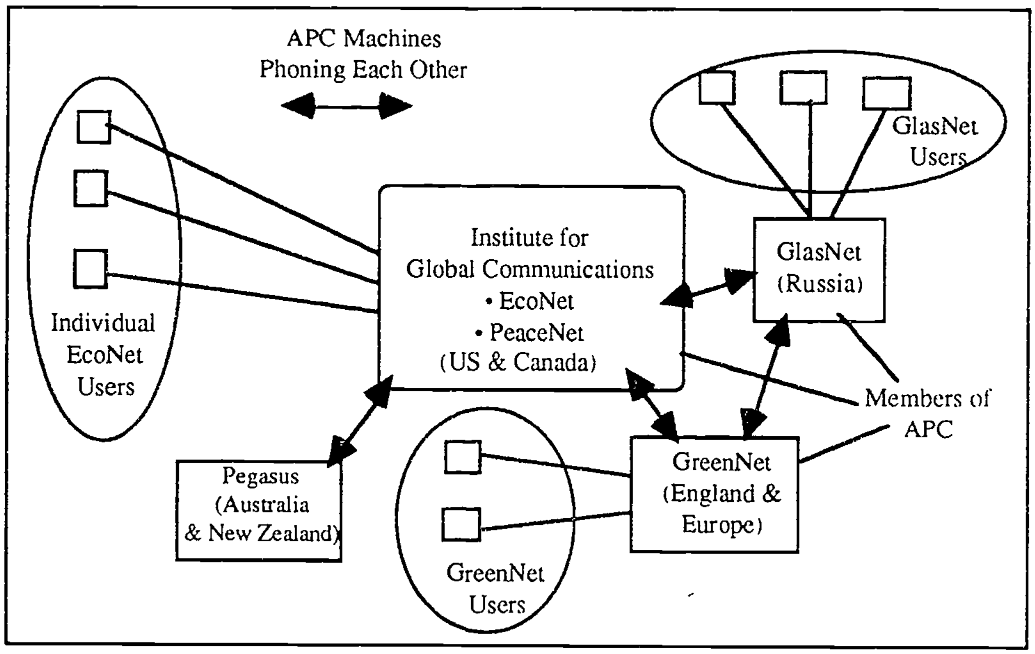


Figure 4. Networks used by the Global Thinking Project

3. Write the word EcoNet, GlasNet, GreenNet or Pegasus on the board. Explain that this is the network (choose the one pertinent to you) that you will be using to electronically connect with other schools in the Global Thinking Project. You should point out that there will be schools from Australia, New Zealnd, United Kingdom, Russia, Spain (the Barcelona region), and the United States. n Use a map of the world to identify these locations.

4. Demonstrate how the computer is used to connect to the network. Connect with your network, and show students the email and conference functions of the system. First go to the (m)ail mode, and list the mail that is in your folder. Explain to students that other schools can send mail to you and them by addressing email letters to them. Inform your class of their email address. (Note: to protect your account, do not let the students know your password).

5. Exit from the mail mode, and enter the conference mode. From there you can visit the Global Thinking conferences. You might visit the gtp.earthconf and explain to the class

that this is where they will receive responses to their conference reports from other schools. Also tell them that it is in this conference that they will send their reports, questions, inquiries and invitations to collabarate on topics they will be studying in the project. Also point out that there is another conference that they can explore. This is the gtp.scientist conference, and it a place where they can ask questions, and get responses from scientists. Exit the conference mode, and from the main menu exit from the network by typing bye.

6. Explain to the students that in the next lesson they will prepare an email note from the class and send it to Gaia. Tell them to start thinking about what they would like to say. Also explain that over the next several days, they will be working in small teams to learn how to send and read email and conference messages.

Key Concepts

Here are some concepts that you might review with the students. You might have one team of students be responsible for creating a poster for one of the concepts and then hang these in the room.

ALICE: A software package that incorporates word processing, data analysis and graphing, mapping, and telecommunications. The ALICE software can be used on Macintosh and IBM computers. It was developed by TERC.

conference: sometimes called a bulletin board, a conference is a "meeting place" on the network in which users can discuss particular topics. Students will use two conferences on the network: gtp.earthconf and gtp.scientists. A third conference is reserved for teacher support and interaction: gtp.teachers.

email: electronic mail; email is similar to an ordinary letter except that it is transmitted between you and your class and other users of the network.

gaia: a virtual character designed to interact with Global Thinking Project participants. Gaia's email address is: gaia1

modem: short for modulator/demodulator; a device that converts (modulates) the electronic signals that your computer and the network understand into signals that can travel over telephone lines, and then convert (demodulates) them back again.

network: in the Global Thinking Project, the "network" includes any of the IGC or APC member networks. Therefore the network includes EcoNet, GlasNet, GreenNet, and Pegasus. In general a network is a collection of interconnected telephone lines and modems attached to a large mainframe computer. The EcoNet, GlasNet, GreenNet and Pegasus "networks" route mail and conference messages.

offline: work done when your computer is not connected to the network.

online: work done when your computer is connected to the network.

telecomputing: the process for transmitting messages or signals over a distance by means of computers connected to telephone lines via modems.

Telecomputing Activity 2

Introduction to ALICE

In this activity small teams of students will practice learning to send messages to themselves to become familiar with the ALICE Network Software. You will have to organize the class into teams of four students, provide a training session for a representative from each team, and then provide time for each team to work on the computer.

Objectives
- to become familiar with the ALICE Network Software
- to learn how to use the computer to send electronic messages
- to know how send and read email reports

Materials

The ALICE Network Software Quick Reference, computer connected to the network via a modem, articles from newspapers and magazines on environmental problems, construction paper, glue, scissors

Procedures

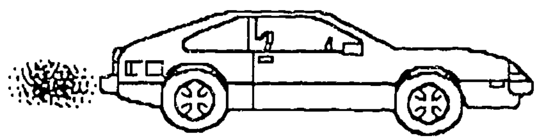
1. Divide your class into teams of four and assign each one of the following roles:
    - communicator
    - tracker
    - checker
    - materials manager

You should distribute the student role cards from Chapter 2 that describe the function of each role. Recall that the communicator from each team is the computer operator. Take a minute to review the all of the roles. The first stage of this activity is for you to work with one student from each group (the communicator), and show them how to write and send an email message, as well as be able to read messages. You might want to bring the communicators together after school, or during a planning period for the initial training.

Note: before you do this with your students be sure that you have used the network system and feel confident using the ALICE Netwrok Software.

2. Assemble the computer/keyboarding (Communicators) representatives from each team, and show them the AlICE Network Software Quick Version booklet (Make a copy of the Quick Version, and have it availavble in a folder next to the computer(s). Tell them that they will be responsible for teaching their teammates how to use the ALICE Network Software. You might want to refer to the ALICE CHECK LIST (See Figure 3) to plan the training session. It is advisible not to try to cover too many functions at once. Start with the REPORT TOOL and the TELECOMMUNICATIONS TOOL and use them as a vehicle to show the students how to write letters, address them, and send them over the Network. At another session you can introduce the DATA TOOL, and later the MAP TOOL.

3. While you are working with the communicators, the remaining members of the teams should be working on an environmental project in which they identify interesting articles from newspapers and magazines that explore environmental problems and issues.



Each team should find three different articles, paste them on construction paper, and write one or two sentence summaries or questions about their articles. Materials managers should retrieve the newspapers and magazines, construction paper, a pair of scissors, and glue for their team. Checkers are responsible for facilitating work on the task. When completed, the tracker should post the articles on the Global Thinking Bulletin Board, and organize the reports in file folders in a class reference library.

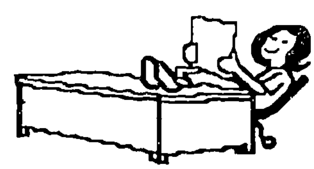
4. After you have worked with the communicators, each communicator will need time to work with their team. Each team should write a short report that they will keyboard on the computer and then send to themselves. To create a report using ALICE, they will use the REPORT TOOL. To create a new report:

1 At the Desktop, click the **Report** icon
2 Click **New**
3 Enter file name
4 Click **OK**

Instruct the students to address the report to themselves.

	Personal name:	User name
From:	Earth patrol	Chattanooga
To:	Earth patrol	Chatanooga

Subject: Message to Earth patrol



The message should then be copied to the Outbox under the File menu. The messages from each group can be put into the Outbox. When all messages are placed in the Outbox, you can then have the students send the mail on the Network. Follow the Connect to the Network procedures and conduct an automatic log in session.

5. If all goes well, all the messages in the outbox should have been sent to the Network. In order for the students to retrieve their messages, they will have to go on line again. The messages they sent should be automatically downloaded to your computer when you go on line this second time.

6. Students should then open the Inbox, and save the messages, which then can be read from the REPORT TOOL.

The check list that follows should be used as a guide to help you use the ALICE Network Software. The checklist does not include all that the ALICE Software can do. However, it does contain the essential skills that you and your students will need to master to work with the software. Rather than introducing these topics all at once, plan a program of training that introduces the ALICE Software in the context of the Global Thinking Projects.

Figure 3. The ALICE Network Check List

1. Find the Network Menu, and use it to:
   a. Enter your local access phone number
   b. Enter your global address (latitude and longitude.
   c. Know how to run a manual session
2. Find and use the address book so that you know:
   a. How to enter a user name in your address book.
   b. How to create a group list (note: this is extremely important since, each time your students send reports and data, they will send them to everyone in their Global Community as well as to the gtp.earthconf.
3. Using the Report Tool to:
   a. Open an existing report
   b. Create a new report including:
      ----typing text
      ----editing text
      ----addressing the report
      ----putting the report into the Outbox
   c. Reply to a report you receive from another Global Thinking school
4. Using the Data Tool to:
   a. Open an existing data table
   b. Create a new data table
   c. Set up columns in a data table
5. Using the Graph Window to:
   a. Make a graph from a data table
   b. Save a graph
   c. Print a graph
6. Using the Map Tool to:
   a. Open the world map
   b. Zoom in and out using the map tool
   c. Make a map overlay
7. Using the Telecommunications Tool to:
   a. Put files in the Outbox
   b. Use the telephone icon to connect to the Network
   c. Save files from the Inbox to the Project folder
   d. Create folders in the Project Folder to organize files that are received from your Global Community
   e. Conduct a manual session
   f. Locate the "Telecommunications Problems" section of the ALICE Reference manual.
8. Other
   a. Enter the maintenance mode in IGC to organize your personal list of conferences, including at least the following Global Thinking Conference:
      • gtp.earthconf
      • gtp.teachers
      • gtp.scientist

      • tr.teacher1.(ALICE Conference?

   b. Know how to send messages to Gaia at IGC (igc:gaia1)

Being a Successful Network Teacher

Margaret Riel and James A Levin[1] have explored the characteristics of successful and unsuccessful computer networking projects. We would like to make you aware of their work so as to increase the probability that your participation in the Global Thinking Project will be a successful one.

First, it is important that you collaborate and talk with other teachers in your school about the project, whether they be working directly with you on the project, or are seen by you as interested colleagues.

Riel and Levin identified six optimal network conditions that they have used as criteria to study network projects. Here are the conditions in the form of questions:

- Does the group already exist?
- Does this group have a need for telecommunications?
- Is there a shared goal or task with a specified outcome?
- Will access to the technology be easy and efficient?
- Will all participants have regular patterns of mail access?
- Is there a person who will facilitate group planning and work?

Let's take a look at each of these and relate them to the Global Thinking Project.

Does the group already exist? The Global Thinking Project was formed in 1989, and has networked a small group of teachers and schools since Spring, 1991. The network now consists of teachers from Australia, New Zealand, Russia, Barcelona, Spain and the United States. Other schools from these and other countries will join the project in near future.

Does this group have a need for telecommunications? The series of projects (Hello, Clean Air, Global Thinking, Ozone, Water Watch and Ozone) have been written to create situations and problems 'n which students in your class will be requested to collaborate with students in other schools organized into Global Communities..

Is there a shared goal or task with a specified outcome? As you will note in the projects that are described elsewhere in the Global Thinking Resource Guide, shared goals and tasks are common features of the activities.

Will access to the technology be easy and efficient? This is a key condition for success. One of the reasons we strongly urge and recommend that the computer and modem be in the classroom of the Global Thinking teacher is to make access to the network easy and efficient. The telecommunications center should be in your classroom, not down the hall in the media center of the school.

Will all participants have regular patterns of mail access? It may surprise you, but many participants in network projects do not read and respond to their mail on a regular basis. In the Global Thinking Project you will have to check your email as well as the three Global Thinking conferences. Using the automatic log in function of the ALICE Network Software, you should be able to check Email and conferences messages at least two or three times pe. week.

[1] Margaret M. Riel and James A. Levin. "Building Electronic Communities: Success and Failure in Computer Networking," in *Prospects for Educational Telecomputing: Selected Readings*, eds. Robert F. Tinker and Peggy M. Kapisovsky. Cambridge, MA: TERC. 1992. pp. 61-85.

One way of relieving the pressure from you is have teams of your students be responsible to checking the network on a regular basis. You could have one team be responsible on a weekly basis. The team would be responsible for logging in and then orgaznizing the messages received in the Inbox.

Is there a person who will facilitate group planning and work? Jack Hassard (jhassard), and Julie Weisberg (jweis) are responsible for coordinating and facilitating the work of the Global Thinking Project. They are the authors of the Global Thinking Teacher's Resource Guide, and will be the conference facilitators on the network. You can contact them at their EcoNet addresses shown in parentheses. Roger Cross is the coordinator in Australia and New Zealand (peg:rcross). Galina Manke is the coordinator for the Russian schools (glas:armu), and Alex Ruiz is the coordinator in Spain (gn:nvives).

Other Questions/Concerns

1. How do I organize information received from others schools? (Use file folders, log messages by topics)

2. If you are doing Global Thinking in more than one class, how do you send information to more than one class? (Identify classes, use "folders,", just use one class to begin)

3. What size class is manageable? (Use cooperative groups)

4. What if you can't work on Global Thinkikng during regular school day? (Clubs, activity periods and after school groups work well with the Project)

5. Should specific projects be assigned to specific content area teachers? (In team teaching situations, specialists can work with different project, although this is not necesasry)

6. How can this best fit into my schedule? (Try and plan on one period per week: be flexible)

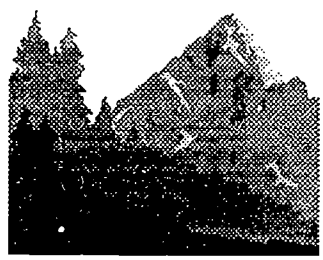
7. How do you get students' trained to use the computer? (Train a core group and let them train other students; rotate kids at the keyboard)

8. How do we share resources with each other? (Send messages to the gtp.teachers conference, use the telephone, or fax)

9. How do you make this more personal? (Follow through on Project Hello with portfolio packages to each school in your Global Community; call teachers in your group, and fax them)

You are now ready to move on to Project Hello! Good luck to you and your students.

Project Hello



What about ourselves
and our surroundings
can we discover
and how can this be shared?

Who are the members of our Global Community of Practice, and what interests do we share?

The goal of Project Hello is to begin the process of creating a Global Community of practice by asking students to introduce themselves, their school and their town to other members of their Global Community. Project Hello represents an opportunity for students to continue to refine their teamwork skills, and to develop confidence using the ALICE Network Software to prepare, send and receive reports.

Students enjoy this process of getting to know each other, and the initial development of good working relationships within and between classes is essential to the success of later projects. However, it is important to move quickly from this initial "getting to know you" phase into environmental monitoring. One way to avoid getting bogged down in Project Hello is to assign each activity (1-3) to one or two teams, so that they are all being conducted simultaneously. If you choose to organize the project in this manner, be sure to provide ample time at the end for individual teams to share their findings with the rest of the class.

Planning Chart: Project Hello

Activity	Title	Telecommunications Alert	Time Allotment
1	Creating the Global Community of Practice: Who Are We?	Yes	2 periods Plus outside time for gathering data
2	Creating the Global Community of Practice: Where Are We?	Yes	2 periods Plus outside time for gathering data
3	How Green Is Our School?	Yes	1 period Plus some time for research and phone calls

PROJECT Hello Activity 1

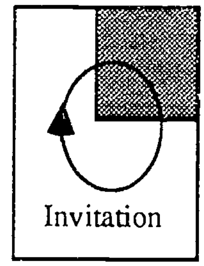
Creating the Global Community of Practice: Who Are We?

A community exists when a group of people with a shared identity and interests interacts frequently.[1] In this activity, students are invited to introduce themselves to other members of their Global Community, and to begin to explore each others' interests and school cultures.

Note: The Global Thinking Project schools are organized into Global Communities of about ten schools on a world-wide basis. To facilitate a sense of community, when Email reports, data, and charts are prepared, they are sent to each member of your community, as well as to the gtp.earthconf. You will work together as a Global Community through Phase I of the Project, which includes the first three projects.

[1]Banks, J. A., 1985. *Teaching Strategies for the Social Studies.* New York: Longman, p. 285).

Objectives



• Students will describe themselves and their school culture, and use a variety of media to introduce themselves to the other schools in their respective Global Community.

Materials

world map
push pins or sticky dots to mark school locations
chart paper
markers

Procedure

1. Create a map of your Global Community by marking the location and name of each school on a large world map, and posting this in your classroom. You might assign each team the task of plotting the locations of one or two of the schools using the Global Addresses (latitude and longitude) provided by the Project.

2. Give each team a piece of chart paper and a marker, and have them brainstorm questions they have about the students and/or schools in their Global Community.

Allowing each team in turn to report one of its questions, compile a master list of questions for the class. Ask if anyone wants to add a question that is not already on the list.

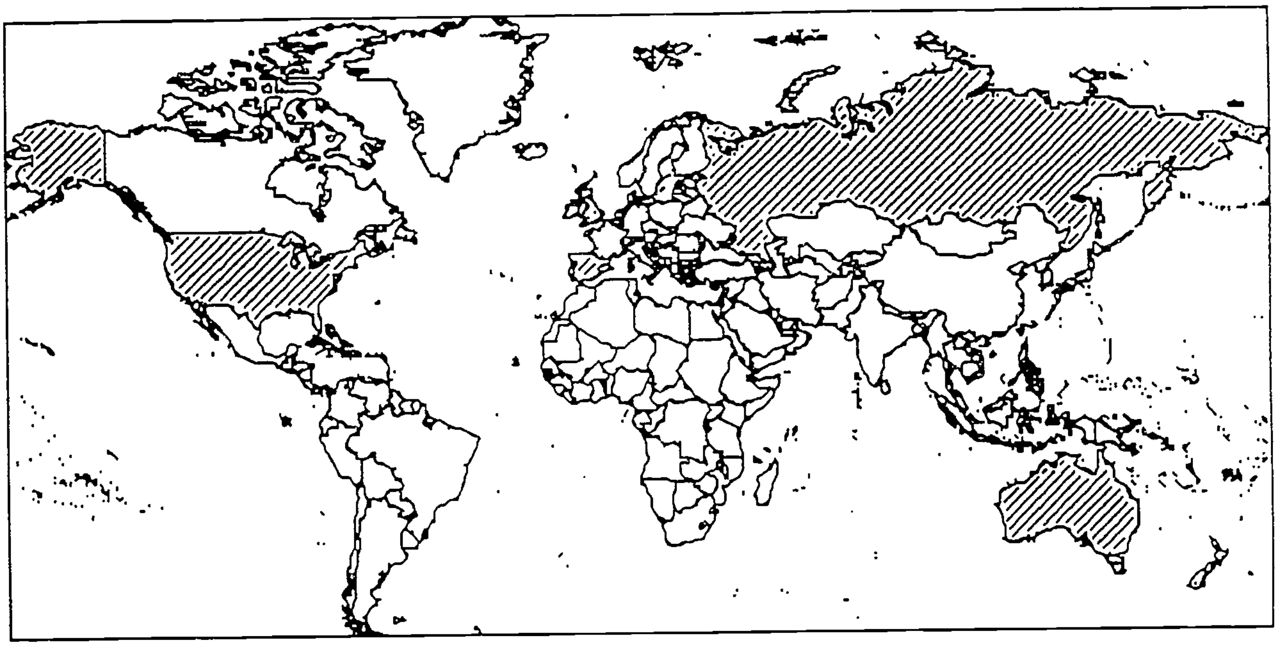
3. Using the class' questions as a guide, create a class profile to share with the other members of your group. This may be accomplished by having each team create its own profile, by categorizing and dividing up the questions and assigning one section of a class profile to each team, or by assigning this phase of the activity to one or two teams while the others complete activities 2 and 3. The final report should include information about the individuals in the class, as well as general information about the class and the school.

4. Have student teams send the report to the Email addresses all of the schools your Global Community, and post the report on the gtp.earthconf for other interested schools to read. This is a good place to make sure that you have created a Group Mailing List in the ALICE Network Software Address Book for your Global Community. The Group List should include the Email addresses of all schools in your Global Community and the gtp.earthconf. The address for the gtp.earthconf should be as follows:

gtp.earthconf@conf.igc.apc.org

5. With your students, assemble **Hello Packets**, small packages of artifacts to be sent to each school in your Global Community via the postal mail system (snail mail). Ask each team to contribute ideas for items to be included in the package. Be sure to include a photograph of the class members with their names, a photograph of the classroom and

school, and some information about your town or school such as a town map or a school or local newspaper. When you receive photos from other classes in your Global Community, add these to the map you created in step 1.

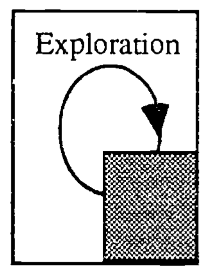


Creating the Global Community of Practice: Where Are We?

The purpose of this activity is to develop a description of the school site, using the five concepts of geography education: location, place, region, movement and human/environment interaction.

Objectives

• Students will characterize their school and its culture.



Materials

flip chart or blackboard
one copy of Figures 1-4 for each "expert" group

Procedure

Note to the teacher: If the whole class is not completing this activity, you will need to assign at least two teams to study the school site and surroundings. Use the JIGSAW method of cooperative learning to conduct this investigation.

1. Assign one person from each team to one of the four "expert" groups (A-D). The assignment sheets for Groups A-D are found in Figures 1-4.

2. Allow time for the expert groups to complete their investigations, and to share their findings with their teams.

3. Teams should prepare reports which can be sent to other members of your Global Community, and posted on the gtp.earthconf.

4. If only a few of the teams from your class have completed this activity, they will need to devise a method for sharing their findings with the rest of the class.

Figure 1: Task Card for "Expert" Group A

Investigate the absolute and relative location of your school and town. The following questions must be answered by your group:

1. What are the latitude and longitude of this town?

2. On which continent is it located? What region of the continent?

3. Near what physical and/or political landmarks is the town located?

4. Locate your town on a world map.

5. Sketch a map of your community, showing the location of the school, and any other significant landmarks you may choose.

Figure 2: Task Card for "Expert" Group B

Survey the physical geography of your region. The following characteristics of the town's physical geography should be described:

1. Terrain (flat, hilly, mountainous?)

2. Climatic zone (e.g. temperate, tropical)

3. Climate (average annual temperature, seasons, growing season)

4. Altitude

5. Precipitation (average annual rainfall)

6. Type(s) of vegetation present

7. Bodies of water (oceans, rivers, lakes)

8. Construct maps to illustrate the physical geography of the region.

Figure 3: Task Card for "Expert" Group C

Group C will characterize the cultural geography of the region, addressing such questions as the following:

1. Is this place a small town, large city/rural?

2. Do people live in houses or apartments? Do they live in single- or multi-family groups?

3. What other types of structures are present? (e.g. government buildings, factories, churches)

4. How is your community similar to or different from nearby communities? (consider, for example, regional dialects, clothing, customs) Describe any unique cultural characteristics of your community.

Attachment 4: Task Card for "Expert" Group D

Explore the movement of people, goods and ideas within the geographic region. The following activities should be completed by your group:

1. Explore and describe (map) transportation systems within your own city or town, and those that connect it with the outside.

2. Select several different types of items from the local grocery: Where did they come from? Via what route? How long did it take for them to get here?

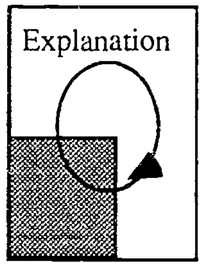
3. Study local newspapers or other news media (TV, radio). What kinds of stories (local, national, international) are covered? In what proportion?

How Green Is Your School?

How would you rate the level of environmental quality and concern in your school? Explore your school site to determine where your school ranks with respect to some common environmental quality measures.

Objectives

• Students will explore the environmental quality of their school site.



Materials

flipchart or blackboard
one copy of Figure 5 per group

Procedure

1. Using the indicators suggested by the Green Cities Study[1] (see Figure 5), develop a survey that could be used to evaluate the environmental quality of your school site.

2. Gather as much information as you can to complete your Green School Survey.

3. Report the results of your survey to other teams in your class, as well as to other members of your Global Community and to the gtp.earthconf.

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[1]n 1991, Professor Susan L. Cutter, in collaboration with the World Resources Institute, used 14 environmental measures to evaluate the level of environmental quality and concern in 64 large (greater than 250,00) U.S. cities. Using these indicators, the Institute developed a Green Cities Index, in which these cities were ranked from most environmentally benign to most environmentally destructive (World Resources Institute, The 1992 Information Please Environmental Almanac. (1991) Boston: Houghton Mifflin Company). Some of the environmental measures used and some information about some of the final rankings are summarized in Figure 5.

Note: When you send data as part of a report to your Global Community and gtp.earthconf using ALICE, you send it as a formatted set of data (see below), or you can create a table using ALICE and include it as part of a report.

Formatted Data for How Green Is your Town?

<waste>, <water use>, <water source>, <energy cost>, <air quality>, <transportation>, <toxic chemical accident risk>, <environmental amenities>, "<school name>," "<town>," <latitude>, <longitude>

Waste	% of budget spent on sewage and sanitation
Water use	gallons per person per day
Water Source	dependent on groundwater sources: Yes or No
Energy cost	Currency ($, Ruble, etc.) per 750 kilowatt-hours
Air Quality	average ozone per hour in parts per billion
Transportation Use	% of work force using public transportation
Toxic chemical Accident Risk	# of releases of toxic chemicals in last ten years
Environmental Amenities	% of budget spent on parks and recreation
School Name	"<name>"
Town	"<town>"
Latitude	dd:mm (degrees: minutes)
Longitude	dd:mm (degrees: minutes

Sample Green Data

22, 135, no, $77, 50, 25, 1, 21, "Coolidge Junior High," "Natick," 42:22, 71:17

Use the technique of formatting data when students compile their reports to be sent to other members of the Global Community. When you receieve data from other schools, you will be able to create a table using the ALICE Data Tool that includes data from all schools in your Global Community.

Figure 5: How Green is your Town?[1]

1. Waste (percentage of municipal budget spent on sewage and sanitation). The top 10 cities in this study spent more than 19% of their annual budgets on cleaning up wastes.

2. Water use and source (consumption in gallons per person per day, and percentage of the public system dependent on groundwater sources). The top ten cities for water consumption used less than 156 gallons of water per person per day. 25 cities did not rely on any groundwater sources.

3. Energy cost ($ per 750 kilowatt-hours). The top 10 cities charges more than $69.00/750 kWh.

4. Air Quality (average 1-hour ozone concentration in parts per billion). The top 10 cities had ozone concentrations less than 110 parts per billion.

5. Transportation (percentage of the work force using public transportation, carpooling rates, average commute time). Only 13 of the 64 cities in the study had more than 10 percent of their work forces riding public transportation to work. New York City had the highest, with 49 percent of the work force using public transportation. Boston, San Diego and Honolulu had the highest number of workers walking to work (8%), while the average commute times for the cities studied ranged from a low of 17 minutes to over 28 minutes.

6. Toxic Chemical Accident Risk (number of releases of toxic chemicals over the past 10 years). Eight cities in the study experienced no releases of toxic chemicals over a 10-year period, while the cities with the most releases experienced as many as 35.

7. Environmental Amenities (percentage of municipal budget spent on parks and recreation). The top 10 cities spent greater than 10 percent (up to 31.1%) of their annual budgets on parks and recreation.

What other measures can your students think of that they could add to their own Green City study?

[1] For more information about the Green Cities study, please consult The 1992 Information Please Environmental Almanac, pp. 169-186.

Optional Extensions for Project Hello

Here are additional activities you may want to use with your class.

1. Compare and contrast profiles from schools in a different region of your own country, or in a different country. What similarities and/or differences can you discover? What might be some reasons for these findings?

2. Select a topic of interest, such as family life, school life, sports, "teen culture," religion, food government, customs and beliefs, or holidays to profile in depth and share with other schools participating in your Global Community. Design a survey instrument to collect information from all the members of your Global Community, and share your findings in the gtp.earthconf.

3. Construct a climatogram for your city or town. A climatogram is a graph that shows the average monthly rainfall vs. temperature. Over what period of time were these data collected? Are any trends evident? Has the climate changed in any significant way over time? Speculate about why. Have the climatic changes had any effects on plant and animal life in your region?

4. Read newspapers, listen to the radio and television, and interview interested citizens to find out what some of the major ecological problems in your town or region are. Discuss your findings with other members of your Global Community, and post your results on the gtp.earthconf so others can discuss your findings with you.

Project Clean Air

The voices of my grandfather said to me,
The air is precious. It shares its spirit with all
the life it supports. The wind that gave me my first
breath also received my last sigh.
You must keep the land and air apart and sacred,
as a place where one can go to taste the wind that
is sweetened by the meadow flowers.

Chief Seattle
Northwest Nations

In this project your students will investigate a significant global problem---the quality of the air. The atmosphere is a very thin layer of gases and solid particles that surrounds the Earth. The atmosphere knows no national boundaries, meaning that the air in one region can be greatly influenced by actions in a distant area.

This project will serve as an example of the principle that global problems have local origins and that careful monitoring and study of the local environment is the first step in being a global thinker.

The intention of this project is to give your students an opportunity to do some hands on science experimenting locally, and then use the telecommunications network to report results and gather data from students in other regions in their Global Community for comparison and discussion. Students will study a primary and a secondary air pollutant in the project by monitoring:

- particulates (primary pollutant)
- ozone (secondary pollutant)

Please note that ozone is a topic that will be visited later in Project Ozone. For now, students will be briefly introduced to the nature of ozone. To monitor these air pollutants, students will use measuring devices (in the case of particulates they will capture solid particles using one of several methods described here; whereas in the case of ozone, they will utilize a chemically sensitive paper strip.

In activities two, three and four of this project, students learn how to monitor the atmosphere. In the last activity of the project (Activity 5), they use this conceptual and procedural knowledge to design a research study to explore air pollution.

Since this project introduces your students to a significant global environmental problem and topic, we would like to emphasize here, and throughout your students' investigations that there are certain key concepts that will impact their study. These concepts are as follows:

Key Global Thinking Concepts

- Change is the norm for any of the Earth's systems:

  Air----Atmosphere
  Ice----Cryosphere
  Life----Biosphere
  Solid Earth----Lithosphere
  Water----Hydrosphere

- Humans recently have been an important agent of change
- The Earth's systems are linked through interactive processes
- Global changes impacts all life.
- Local changes have global consequences[1]

Two other concepts emerge as students explore global environmental problems. The first is stewardship and the other is appreciation. Stewardship means making informed decisions about the Earth's systems and resources, and maintaining a high-quality environment. The activities in the Global Thinking Project contribute to this by making students aware of the issues and problems, and showing them how to gather information to make reasonable decisions. Appreciation is significant because students daily lives will be enriched if they know more about their environment, and are able to find out about the environments of their peers in distant locations. Your students' investigation of the local environment coupled with access their peers' environments via telecommunications should give them a greater appreciation of the planet Earth and its environment.

As you begin this project, take some time and discuss these overarching concepts with your students. You might use them as a basis for a large chart or poster that can be posted in your room.

Planning Chart: Project Clean Air

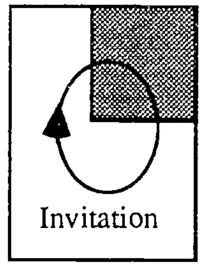
Activity	Title	Telecommunications Alert	Time Allotment
1	A Clean Breath	No	1 period
2	Monitoring Air	Yes	2 periods
3	Monitoring Particulates	Yes	2 periods
4	Monitoring Ozone	Yes	2 periods
5	Collaborative Air Quality Studies	Yes	2 periods

[1] Based on Ground Truth Studies, Aspen Global Change Institute, 100 East Francis Street, Aspen, CO 81611

A Breath of Clean Air

Students are invited to share what they know about air pollution by participating in a brainstorming activity. They work in small teams to discus and create a chart of what they've heard and questions they have about air quality. The results are posted on charts and hung in the classroom for referral throughout this project.

Objectives



• Assess students prior knowledge of air pollution
• Generate questions about air pollution
• Identify causes of atmospheric change
• Identify reasons why atmospheric monitoring is important to our understanding of weather and climate change

Materials

Chart or construction paper, crayons or marking pens, masking tape, 6-6 cm lengths of sticky tape that has been placed outside for a week, article from a newspaper or magazine about air pollution (story about a smog alert, volcanic eruption, effects of acid rain, pollen and health, ozone).

Advance Preparation

One week prior to the first lesson you should collect examples of atmospheric suspended particulates. You can do this very easily by placing sticky tape (sticky side up) outside in an unobstructed area for a day (or just an hour or so depending on amount of pollution). Solid particles---dust, pollen, soot---will be deposited on the sticky tape.

Procedures

1. Divide your class into teams of four students. You should use a random method when forming the teams, and inform the students that they will be working together for the duration of Project Air Quality. Give each team an index card that has a piece of sticky tape that has been placed outside for a week. Tell the students to observe the card, and describe what they see. What do the specs look like? Can they identify them? How many are on the card? What is the source of these objects? Give the teams five minutes to make their observations, and answer these questions. Follow this up by asking a student from some of the groups to report their teams' findings.

2. Tell the students that they are going to begin a study of Project Air Quality---an investigation of air pollution, from a local as well as global scale. Read a few paragraphs

from an article on air pollution (find one from a local newspaper or magazine) to highlight the nature of air pollution, and problems associated with polluted air. Discuss the article with the students.

3. To find out what your students have heard about air pollution, and what questions they have, conduct this very brief activity with them. Show students a T-Chart drawn on a large sheet of newsprint paper (see Figure 1), and ask them to brainstorm answers to two questions:

- What have you heard about air pollution?
- What questions do you have about air pollution?

Give students ten minutes to generate a list of answers to these questions. To make sure everyone contributes, have the tracker go round in a circle asking each person "What have you heard about air pollution?" The tracker then writes their responses on the chart paper. By going a round a couple of times, the group will generate a list very quickly. Have them repeat the process for the second part of the T-Chart. When the teams are finished, tell them to look their lists over again, and select the most important item on each list. Have them circle these items on their chart paper. The communicator should record their team's decisions on a master chart on the chalkboard or on a chart. Discuss the results with the class and use the discussion to focus on air pollution, its causes, and what can be done to maintain "clean air." Hang the individual team T-Charts in the room. You will be able to refer to these throughout the project.

Note: The purpose of this activity is to enable the students to talk about their initial ideas of air pollution. There will be misconceptions, and misunderstandings in the list of concepts they identify as responses to the first question. It is not necessary to "correct" these misconceptions, but to make use of their ideas as you continue with this project. The questions that the students listed are also important. In the activity of this project, your students will be designing research projects. The heart of a good research study is a list of interesting questions for inquiry. Make sure that you return to the student's initial questions when you reach activity five.

What have you heard about air pollution?	What questions do you have about air pollution?

Figure 1. T-Chart to find out what students know about air pollution

4. Ask the students to think about the following questions. Give each team a card with a different question on it. Tell the team to discuss the question for two minutes and write their ideas on a separate sheet of paper. Exchange cards so that each team gets a new

question. Continue the process so that each team has a opportunity to discuss each question. Discuss the student's ideas with whole class. To maintain a sense of positive interdependence, randomly call on students from the teams to respond to the questions. Use numbered heads together. Make sure everyone in each team has a number (1, 2, 3, etc.). Draw a number from a set of index cards which have the numbers 1-4. The person in each group whose number is drawn stands and responds to the question for the group. Repeat the process as you discuss each question.

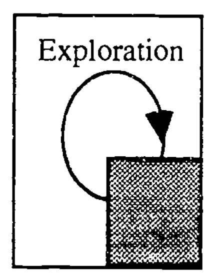
- How does the quality of the air impact you directly? How does it affect other living things in the environment?
- What is "clean air," and what causes the air's quality to change?
- How do you think the quality of the air in your region compares to regions close to you, as in places quite far from you?

PROJECT Clean Air Lesson 2

Monitoring the Air

In this activity students will be introduced to the concept of monitoring, and learn how to monitor important atmospheric variables, e.g. temperature, humidity, cloud cover cloud type, visibility, wind and the weather.

Objectives



- Explain why monitoring the quality of the air is important to themselves as well as other living things and their environment.
- Collect and organize data on several atmospheric variables

Advance Preparation: You'll need to take your class outside briefly in this lesson to monitor the air. Select a location in advance that is conducive to viewing the sky, and making temperature and humidity measurements.

Materials

Thermometers, small pieces of cloth, rubber bands, water, relative humidity charts from a science textbook.

Procedures

1. Have your students imagine that they are members of air quality research teams and that their job is to monitor the air in their local environment and be prepared to share their research results with other student research teams. Tell them they will use the computer network to share and collaborate with students in their Global Community.

2. Ask the class, "What are some factors about the air that might be important for an air quality research team to monitor?" Give each team three to five minutes to jot down what their team thinks. Write the team's suggestions on a master list on the board. Using the ideas the students have suggested, work with the class to come up with a set of observations that you and they think are important.

3. Help the class generate a master list of observations and then a data table using the ALICE Data Tool. (see Figure 2). Give students data tables such as the one shown in Figure 2 for them to use to record their data. Here are some observations that you should include:

1. Air Temperature
2. Relative Humidity
3. Cloud Cover
4. Sunshine
5. Wind Speed
6. Wind Direction
7. Precipitation
8. Latitude
9. Longitude
10. School
11. Date

Your students might have also included these observations: pollen, particulates, ozone, haze, fog, smog, soot. You can include these if you wish, but you might want to direct them to focus only on the list given above. In the next two lessons, they will focus first on monitoring particulates, and then ozone. But these require monitoring devices that you should not introduce in this lesson.

Figure 2. Sample Weekly Air Monitoring Table

File: Sample Air Quality Table   Page 1 - 1

Row	Temp	Rel. Hum.	Cloud Cover	Sun-shine	Wind Speed	Wind Direc.	Precip	Lat.	Long	School	Date
1											
2											
3											
4											
5											

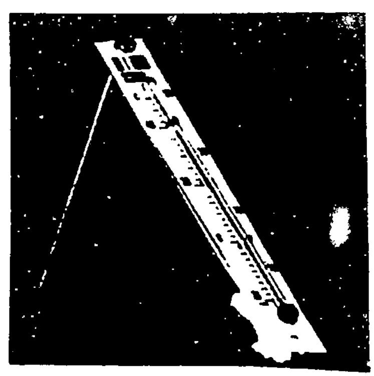
4. Discuss the types of measurements and observations that should be made for each of the variables:

Air temperature: use a thermometer and measure in degrees Celsius.

Humidity: report the relative humidity. Use a psychrometer, which is simply two thermometers, one of which is a "wet" bulb and other a "dry" bulb. To make a "wet" bulb, wrap a small piece of cloth around the bulb of a thermometer and fasten it with a rubber band. To measure relative humidity, find the difference between the "dry" bulb temperature and the "wet" bulb temperature. Use the information in Figure 3 to determine the relative humidity.

Constructing a Sling Psychrometer

Attach two thermometers to a wood dowel with a screw. Fasten a piece of cloth to one of the thermometer bulbs with a rubber band. To use, dip the bulb with the cloth in water. Sling the thermometers around in the air for a few seconds. Read the wet-bulb temperature. Repeat until the wet-bulb temperatures stops dropping. Read the dry-bulb temperature. Use the chart in Figure 3 to determine the relative humidity.



Sling Psychrometer

Cloud Cover: Determine the percentage of the sky that is covered with clouds as follows: 0-25%, 25%-50%, 50%-75%, 75%-100%. Simply eyeball the sky to estimate the percentage of cloud cover.

Sunshine: Have the students estimate the amount of sunshine using this verbal scale: sunny, mainly sunny, mainly cloud, cloudy

Wind: Estimate the velocity of the air in km/hour, and the wind direction.

Precipitation: Describe the type of precipitation (rain, snow, sleet, none), and the amount of precipitation in the last 24 hours in cm.

	Difference Between Wet- and Dry-Bulb Readings (^{0}C)				
Dry-Bulb Reading (^{0}C)	**1**	**2**	**3**	**4**	**5**
10	88	77	66	55	44
11	89	78	67	56	46
12	89	78	68	58	48
13	89	79	69	59	50
14	90	79	70	60	51
15	90	80	71	61	53
16	90	81	71	63	54
17	90	81	72	64	55
18	91	82	73	65	57
19	91	82	74	65	58
20	91	83	74	66	59
21	91	83	75	67	60
22	92	83	76	68	61
23	92	84	76	69	62
24	92	84	77	69	62
25	92	84	77	70	63
26	92	85	78	71	64
27	92	85	78	71	65
28	93	85	78	72	65
29	93	86	79	72	66
30	93	86	79	73	67

Figure 3. Relative Humidity Chart.

5. Have the materials managers get the equipment and a chart for their team. Each team will need two thermometers, rubber band, and small piece of cloth. Have the teams divide the responsibility for making observations among the team members. The tracker should record the data for the team. The checker should make sure that each person performs the following functions when they go outside to monitor the atmosphere:

- Communicator----determine cloud cover and sunshine
- Tracker---prepares chart and records data for the team, and measures precipitation
- Checker---determines wind speed and direction
- Materials Manager: uses psychrometer to determine temperature and humidity.

6. Take the students outside, and show them where to make the observations. Give them about ten minutes to make and record their observations.

7. After the students have returned from their first monitoring exercise, tell them that they should monitor the air each day this week, and two persons from each team should be responsible for each day's readings. Make sure that everyone participates in the monitoring activity. You might have the materials ready for the team when they get to class each day. They could make measurements at the beginning of class, or at the end.

Note: Another way to collect data is to give each team a different assignment. In this approach to cooperative learning (Jigsaw), one team makes temperature and humidity readings, another sunshine and wind, and so forth. The data could be pooled in class data chart. Or you could make a different team responsible for a different day.

8. Have each team post their data on a wall in the room and record their daily observations for all to see.

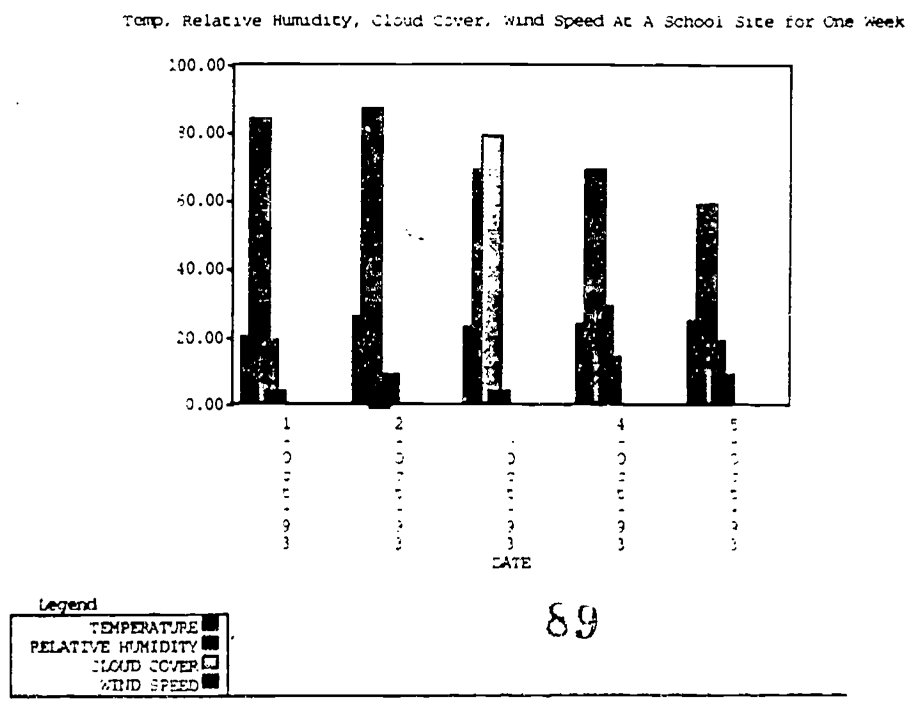
9. At the end of the one week monitoring period, you should have the students analyze the data, and make comparisons for the data that was collected. Using the ALICE Data Tool, students can prepare a Table of their data, and create graphs to answer questions they have about their data. One way to do this is to graph the data. For example, Figure 4 shows one way of the making a graph with ALICE that plots the data on a single chart. Students can then ask questions such as:

- Is there a relationship between temperature and humidity?
- Is there a relationship between temperature and cloud cover?
- Is there a relationship between wind direction and temperature?

When students begin monitoring air pollutants, they can add these new variables to their data, and ask new questions about the relationship among the various variables.

Note: For those of you working with younger students, you may want to limit the number of variables that students investigate at the same time. For instance, very interesting studies can be done by looking at two or three variables. For instance, when students investigate particulates, they may want to explore the relationship of particulates to visibility and temperature.

Figure 4. Sample Weekly Air Monitoring Graph



10. For those of you who are interested in setting a long-term study of weather monitoring, you might want to continue the process for several months, or for the entire year. An interesting notion is for you to establish your school as a school-based monitoring site that could work in collaboration with other schools in your Global Community. We'll talk more about this in activity five of this project.

11. Tell the students that in the next lesson they are going investigate a primary pollutant. and learn how to monitor and conduct experiments that will give them some insight into the quality of the air locally. They will then share their results over the network with others so that they can compare the quality of the air in different regions.

PROJECT Clean Air — Lesson 3

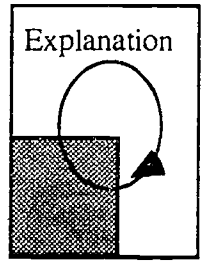
Monitoring Particulates

Suspended particulates are actual pieces of ash or smoke, soot. dust and liquid droplets released to the air by the burning of fuel, industrial processes, agricultural practices, and number of natural processes. For example, volcanic eruptions can spew tons of ash particulates as high as 10 -15 miles into the atmosphere. Winds aloft can carry these particulates around the planet, and depending on the amount and size of the particles, they can stay aloft for years, affecting sunsets, and average world temperatures.

Particulates, when inhaled, can lodge in the lungs and contribute to respiratory disease.

For example, a study reported to an international conference of the American Lung Association finds that tiny airborne particles help to kill many people weakened by old age, heart problems. or lung disease. The study concluded that as many as 3 percent of deaths in the United States are attributable to suspended particulate matter. despite particulate levels in most urban areas that are well below the health standard set by the U.S. Environmental Protection Agency---a limit of 150 micrograms per day. The tiny particles in the air become lodged in people's lungs, making breathing more difficult.

In this activity, students will learn to use a method to monitor particulates in their own environment (indoors or outside). The methods will involve making a piece of equipment from ordinary materials. and then collecting samples of particulates from different locations for comparisons.



Objectives

• Design a device that can be used to monitor the quantity of solid particles (particulates) in the atmosphere
• Detect and measure particulates in the local environment
• Communicate the results of their work with others in the Global Thinking Network

Materials

file folders, card stock or 10 cm X 15 cm index cards, clear sticky tape, plastic margarine or butter containers, balance, large glass jar with a cover, paper, matches

Procedure

1. Start the lesson with a brief demonstration. Ignite a piece of paper, and drop it into the large glass jar. Cover the jar. "Smoke" will fill the jar. Ask the students how the "atmosphere" inside the jar changed as a result of the burning of the paper. Students will respond with statements such as :"The smoke made the air dirty." "Carbon particles filled the air in the jar." Help the students realize that particles from the burning process were released into the air in the jar. These particulates are air pollutants. Ask the students: Can you name some sources of particulate air pollutants in the atmosphere." Students will mention smoke from the burning of wood, dust from soil, pollen, wind blown sand, dust from volcanoes, soot from factories, and so forth.

2. You might point out that particulates do cause harm to humans. Read the report of the research study, and show the students the graph of the amount of particulates put into the atmosphere just in the United States from the period 1970 - 1989 (Figure 5). Point out that particulates are one type of air pollutant. Air pollutants can be solid, liquid or gaseous. Particulates are examples of solid pollutants. An example of a liquid pollutant is acid rain (which will be explored in another project). Examples of gases in the air that are pollutants are carbon monoxide, sulfur dioxide, nitrogen oxides, and ozone. Ozone will be explored in the next activity, as well as a separate project later in the year.

3. Examine the two methods to monitor particulates, and choose either or both to use with your class. In one method students use the Air Quality Monitoring Card to collect samples of particulates from various sites around the school. The cards are inspected and the particles are counted by size. In the Dust Bucket Method, students use a small "bucket" to collect samples over several days. The bucket is weighed before and after being placed at a collection site to determined the mass of the suspended particles. A fairly sensitive balance is required.

4. Give the students the materials to make a device to monitor atmospheric particulates. When the devices are ready to use, have the students place the devices at various locations inside and outside the school. Inside the school, they might choose the cafeteria, their classroom, principals office, laboratory, gymnasium, etc. Outside they might select sites such as near the road, near trees, in an open field, near the parking lot or

area near automobiles. Students can record data on particulates using the Data Recording Form shown on the next page.

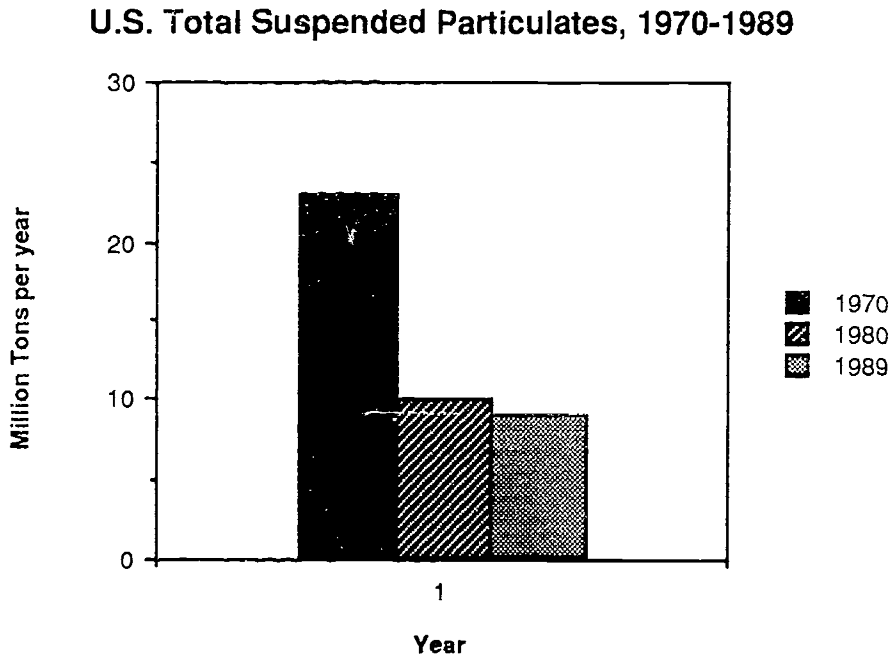
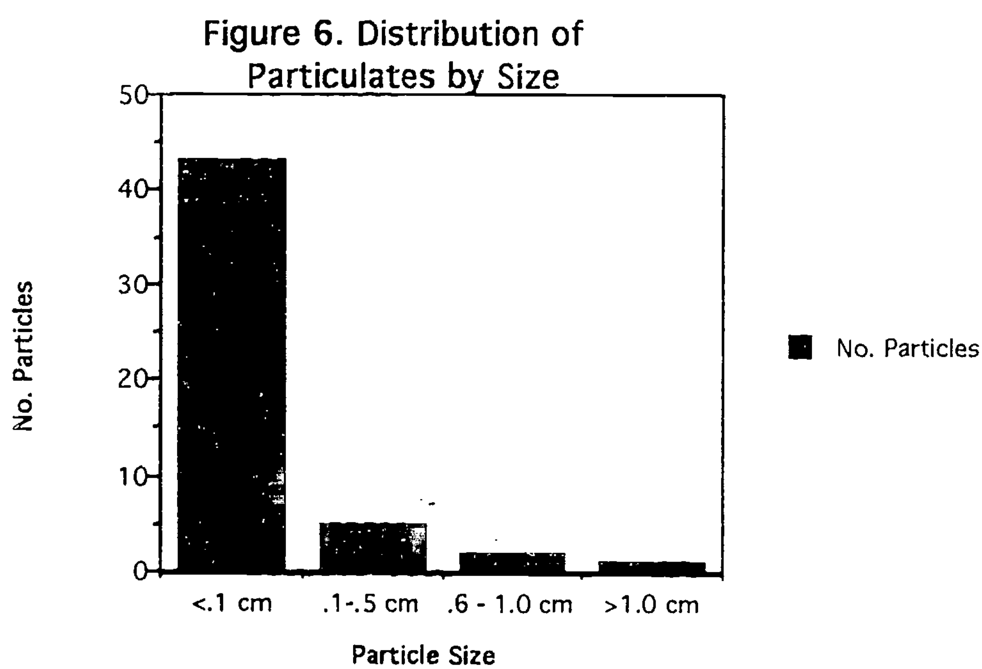


Figure 5. US. Total Suspended Particulates, 1970-1989. Source: 1992 Information Please, Environmental Almanac, World Resources Institute



Project Clean Air
Particulate Data Form

Team Name: ______________________ Team Members: ______________________

Measurement Location: Inside: ________________ Outside ________________

Starting Date: ____________ Starting Time: ________________ Latitude: __________

Ending Date: ____________ Ending Time: ________________ Longitude: __________

Method Used: Sticky Tape Cards Dust Bucket Other: __________

Observations

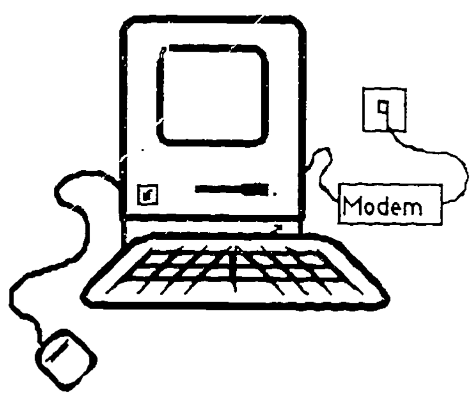
Particulate Count: High Moderate Low

Type of Particulates: ____

Size of Particulates
(% in each category) _____ <0.1 cm: _____ 0.1 - 1.0 cm; _______ > 1.0 cm

Other Observations &:
Calculations (Dust Bucket
Method) ____

5. Have the teams analyze their data, and the effectiveness of the method they used. Were there any problems that they encountered? What were they? How can they change their methodology to improve their results? Each team should summarize the results of their monitoring activity, and send it to schools in their Global Community, and post it in the gtp.earthconf, as well as on the Global Thinking Bulletin Board in their own classroom. (Figure 6 shows a graph summarizing one teams data). Encourage the students to formulate brief messages for this activity. In the case of the Air Quality Monitoring Card, they might report the results they got in terms of the distribution and types of particles, as well include a statement evaluating the effectiveness of their method, and any suggestions that might help other student teams use this method.



Telecommunications Alert

Monitoring Particulates
Method 1:
Air Quality Monitoring Card

Design

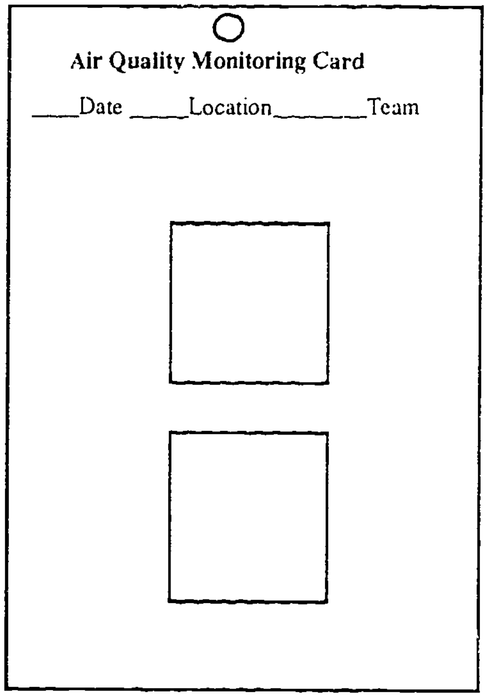
1. Give each team copies of the Air Quality Monitoring Card, clear plastic tape, scissors, and string.
2. Have the students cut out squares (2.54 cm) as shown on the card. Cover each square "window" with a piece of clear plastic sticky tape. Make sure the sticky side is placed on the underside of the card so the sticky side is facing "out."
3. Punch a hole in the top of the card, and fasten a piece of string through the hole. The card can be suspended to objects for monitoring. The card can also be tapes to objects, as well.
4. Complete the data and location, and team name, then carefully place the card in the desired location.

Methods of use:

• Hang the card in different locations, and compare the results at the end of 24 hours. Students should use a magnifying glass or microscope to inspect the cards. Estimate the number of particles in the following size categories: <0.1 cm, 0.1--.5 cm, 0.6 - 1.0 cm, >1.0 cm.

• Hang the card in a location for 7 days. At the end of the period you can count the actual particles with a magnifying glass. Particles can be counted within the square. Report actual numbers. If there are too many to count estimate the number of particles. More than 500 indicates high particulate count; less than 500 indicates mild particulate count.

• Weigh the card before is placed at the site, and then weigh it after a 7 day period of monitoring. Report the values in grams.

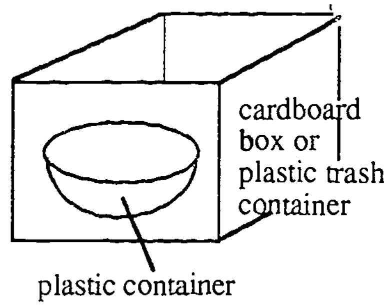


Note: Use this design as a template to make copies for your students.

Monitoring Particulates
Method 2:
Dust Bucket Method

Design

1. Provide each team with a plastic container (margarine or butter container, a large cardboard box (at least 25 cm high) or a small plastic trash container, foil scissors.
2. Cut holes in the large cardboard box or trash container to provide for circulation.
3. Place the small plastic container inside the large box. Make sure the small plastic container does not protrude above the sides of the box.
4. Your Dust Bucket Method is ready for use.



Methods of Use:

• Prior to any usage, the plastic container should be washed and then rinsed with distilled water, and air dried. Weigh the plastic container before it set in a monitoring location.

• Place the plastic container in the box and cover it with foil or plastic wrap, and then take it to the monitoring site. It should be left there for at least 7 days (two weeks is better).

• If it rains during this time, you may have to pour some of the rain water out. Do not pour all the water out, however.

• At the end of the monitoring period, bring the apparatus into the classroom for analysis.

• Weigh the plastic container (after any water has been allowed to evaporate). If there is a lot of water, transfer the water-dust mixture to a clear glass jar and make sure all the mixture is removed. Evaporate all the water by heating the water.

• To calculate the mass of the particles, subtract the weight of the empty container or beaker from the weight of the beaker + particles:

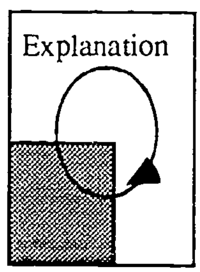
Weight of beaker with particles - weight of beaker = weight of particles

• With this figure, have students make estimates of the amount of particulates over larger areas.

Monitoring Ozone

Most of your students have probably heard of "smog." Smog forms when primary pollutants such as nitrogen oxides (NO_x), which are produced by burning fuels, and volatile organic compounds (VOCs) escape into the atmosphere. VOC_s are unburned hydrocarbons produced by automobiles fuel tanks, other chemical from commercial enterprises, and natural sources such as trees. In the air, these chemicals react or combine with sunlight to produce a number of different materials, the most common of which is ozone (O_3). Because of this, ozone is an example of a photochemical smog. This form of ozone is concentrated in the lower atmosphere (the troposphere), where it comes in contact with plants and humans. High levels of ozone can result in eye irritation and respiratory problems. Ozone can also damage plants. It damages the leaves and slows growth. In this activity, students measure ozone levels in and around their school using a chemically treated paper, called Eco™Filter. City smog is a serious global problem, and one worthy of investigation.

When students hear the word ozone, they probably are going to bring up the "ozone hole." The ozone hole refers to ozone located in the stratosphere which protects us from the ultraviolet rays of sunlight. Although students are not going to investigate the "good" ozone in this project, they will want to talk about it. You might tell them that certain chemicals such as chlorofluorocarbons (used in refrigerators, air conditioners, aerosol sprays, cleansers for electrical parts), float to the stratosphere and photochemically react with ozone. The CFCs react directly with ultraviolet light releasing chlorine. The chlorine atom reacts with and destroys the O_3. The destruction of the ozone layer is considered to be one of the most serious global problems of the day.



Objectives

- Measure ozone levels in the local environment
- Compare ozone measurements with students from other locations
- Communicate the results of their work with others in the Global Thinking Network

Materials

Eco™Filters[2] (ozone test strips), graph paper, thermometers, psychrometers, Project Air Quality Recording Form

[2]Order from Vistanomics, Inc., 230 North Maryland Avenue, Suite 310, Glendale, CA 91206 Fax: 818/409-9334; Tel: 818/409-9157

Procedure

1. Explain to the students that today, they are going to investigate a second type of pollutant, one that is produced when primary pollutants combine in the atmosphere to produce a secondary pollutant. To start off, ask students what affect a "Smog Alert" would have on the activities of people. What cities might be likely to have smog alerts? Why? What is smog? What affect do they think temperature has on smog? Discuss smog with the students, and point out that the main constituent of smog is ozone. You might want to use the introductory material in this project to give a short presentation on ozone. Follow this by having student pairs turn to each other, and draw a diagram that shows how tropospheric ozone differs from stratospheric ozone.

2. Show the students an Eco™Filter (a small strip of filter paper that has been treated with two chemicals---one that is sensitive to ozone such that in one hour it turns a shade of violet, and another that is sensitive over an eight hour period and turns a shade of brown. (Figure 7) We will refer to the Eco™Filter as an ozone test strip. Tell them that they will be using the ozone test strips to measure ozone.

3. Describe how the ozone test strips are used. Briefly, you should tape the ozone test strips on a small index card (see Figure 7). Since the chemical works when it is exposed to the air, the students must work quickly. If you are going to do a one-hour test, you should cut the strips, and give students only the top part of the strip (the one-hour test circle). This should be taped to the card.

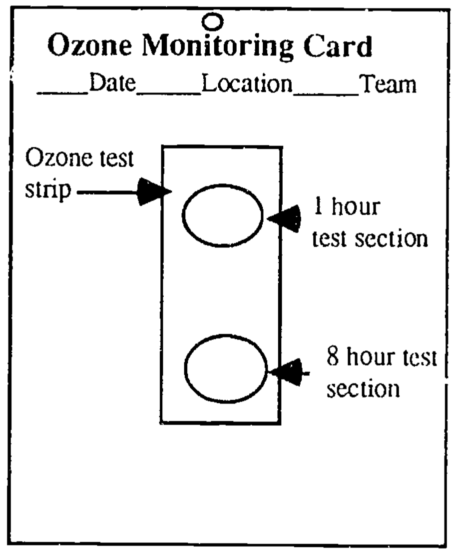


Figure 7. Ozone Test Strip & Monitoring Card

Another technique is to cover the test strip with a piece of clear acetate. Cut small holes the size of the test sections and tape the acetate directly over the ozone test strip. Cover the 1 hour test section with one of the circles of acetate. You can then run an eight hour test, and then choose when you do a 1 hour test.

When students place the card in the monitoring location, they should observe the temperature, humidity, cloud cover, cloud type, visibility, and weather. Provide data tables for students to record their data.

4. You should decide with the students where the ozone test strip cards should be placed for this first test. A simple approach is to place the strips on the outside of a window in your room, in a room close to your class. Since the strips will need to be exposed for an hour, you will have to make arrangements in case students leave for another class for the gather the strips.

5. To read the strips, the color on the ozone test strip should be compared to the Eco™Filter color patch chart. To get best results, have the students fold the filter in half, and place the filter directly on the chart. They should try and match the color of the ozone test strip to the colors on the color chart. It is important to point out that they might not always get perfect matches, so they should focus on the intensity of the color.

Note: If you use the eight hour test circle, but don't leave it exposed for the full eight hours, you can use a time weighted formula to calculate the ozone level. The formula is

8 hours/number of hours exposed X reading on scale = time weighted ozone level

For example, suppose the strip was exposed for four (4) hours, and the reading was 50 on the color scale. Then the time weighted ozone level would be: 8/4 X 50 = 100 ppb

6. To interpret the meaning of the ozone level, share the data in the chart shown in Figure 8. The U.S. Environmental Protection Agency has established 120 parts per billion of ozone has optimal level of ozone allowable under the law. That is, if a reading is made that exceeds 120 ppb (even for one day), then that community is not in compliance. Naturally, some cities have a more serious problem than others. For example, these cities have had smog levels above standards per year as follows: Los Angeles (155), New York (20), Houston (20), Atlanta (5), Fresno, CA (21), Bakersfield, CA (29).

Air Quality	Good	Moderate	Unhealthful	1st Stage Alert	2nd Stage Alert
PPB on Eco™Filter	10 - 50	100 - 150	200 - 250	300 - 350	>350
Part per billion	<60	70-120	120-190	190-340	>340
Ozone Index reported to public. (ozone level/120 X100)	50	58 - 100	100 -158	158 - 280	>280

Figure 8. Ozone Conversion Table[3]

7. Student teams should have the opportunity to use the ozone test strip before going on to activity five in this project. If you have students who can collect data at different times of the day, then you could investigate ozone levels on a daily basis, and report data such as shown in Figure 9. When students collect data, have them use the form shown in Figure 10.

[3]Based on *Let's Clear the Air About Air™ (High School)*, Glendale, California: Vistanomics, Inc., 1992, p. 20.

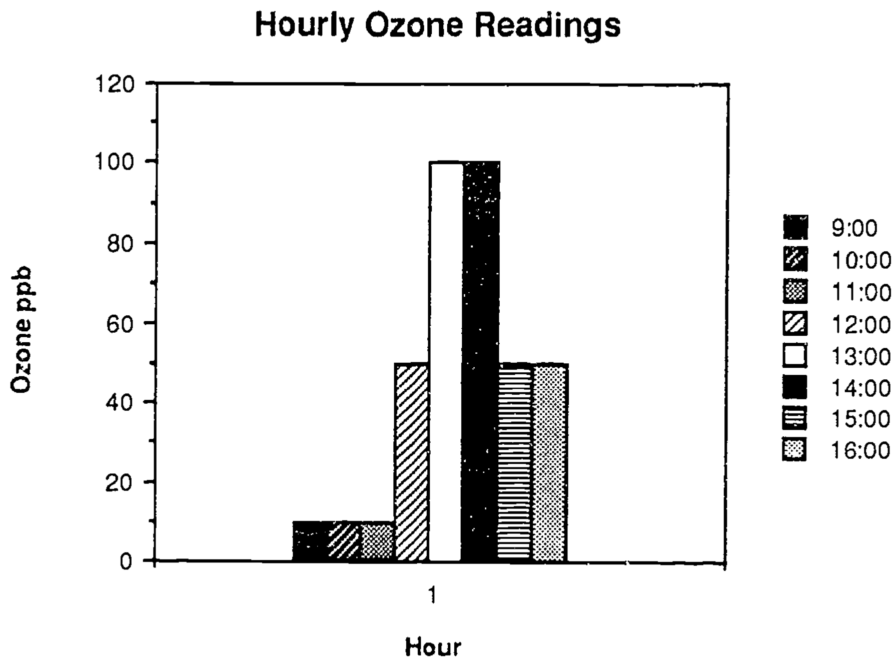


Figure 9. Hourly ozone readings on a summer day in Savannah, Georgia

8. Student teams should collaborate, and formulate a brief report that should be sent to their Global Community schools, and the gtp.earthconf. Have the students discuss the use of the ozone test strip, and report their findings. They should also check their Email for results from other schools, and post these results on their Global Thinking Bulletin Board.

9. As students think about the use of the strips for future research, discuss some possibilities by showing them Figures 12 and 13 that depict the results of two different kinds of studies, one local and other global. Tell the students that they are going to design an air quality research study and interact with other students over the network.

Figure 10

Project Clean Air
Recording Form

Team Name________________________ Team Members:____________________

Measurement Location: Inside, Outside

Date:________________________ Latitude:____________________

Start Time:____________________ Longitude:____________________

Quantitative Measurements

Ozone (EcoBadge Readings)

Location	Start Time	End Time	Reading 1 ppb	Reading 2 ppb	Reading 3 ppb	Average ppb

Temperature: ___________ ^{o}C

Relative Humidity: ___________%

Wind Speed ___________km/hr

Wind Direction ___________degrees

Precipitation ___________cm

Qualitative Observations

Circle one of the words to describe your observations:

Ozone	Good	Moderate	Unhealthful	1st Stage Alert
Temperature	Hot	Warm	Cool	Cold
Humidity	High	Average	Low	
Clouds	Cloudy	Partly cloudy	No clouds	
Sunshine	Sunny	Mainly sunny	Mainly clouds	Cloudy
Wind Speed	Strong	Medium	Light	Zero
Wind Direction	North	East	West	South
Precipitation	Rain	Drizzle	Snow/sleet	None
Particulates	High	Moderate	Low	

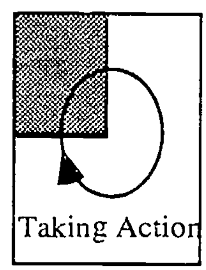
Other Observations:

Collaborative Air Quality Studies

The locus of this activity is student designed collaborative projects that focus on solutions to questions posed by your students about air pollution. Student should work in cooperative teams to design and carryout their projects. Students will be involved in the following procedures:

- brainstorm questions that they would like to investigate about air pollution
- design a research method or set of procedures to help them answer their question(s)
- monitoring the variables that are being investigated in their study
- analysis of data including both graphical and verbal analysis
- summary of the results and an evaluation of the methodology
- engagement of others via the telecommunications network; this can simply be the reporting of their research plan and results, or it can go as far as designing project that depends on the participation of students in remote classrooms
- responding to network invitations to collaborate with other student research teams

Objectives



- Design research projects based on questions and inquiries about air quality
- Identify, discuss and use research skills to answer scientific questions
- Use computer-based technologies to collaborate with students in their Global Community

Procedure

1. Begin the activity by writing the phrase: *Act Locally, Think Globally* on a large sheet of paper or on the chalkboard. Tell the students that they are going to "act locally" by doing a project that focuses on air pollution in the local environment. However, because they are part of telecommunications network that brings them in touch with students around the world, their study can have a global dimension.

2. Discuss with your students the nature of a research project. You might begin by posing a question to your students, and then asking them how such a question might be answered.

Are there more particulates in the air on windy days than on days when there is just a slight breeze? or

Is the ozone level near plants (such trees and shrubs) different than the ozone level in an open field?

Give each team an assignment to design a study that would answer one of the questions. Tell the students simply to list the steps (or the method) they would use to answer the question they have been given. When the students are completed, ask each group to very briefly describe the method of their study they designed.

3. Use the discussion and the reports to introduce your students the procedures to follow to carryout a study. The following steps should be followed. A checklist summarizing these steps is shown in Figure 11. Give the checklist to each team, and use it as a guide with them as they work on their project.

Step 1: Brainstorming Questions: Brainstorm a set of questions, and agree on a focus for the study. Students should reflect on the work the have done so far on air quality, and suggest to each other questions about atmospheric monitoring, particulates, and ozone. You might have them look at the initial list of questions they wrote in Activity 1, and see if there are any there they would like to tackle.

Step 2: Agree on Questions: Using consensus, students agree on the research question(s) they wish to investigate. Once they agree on the questions, they should write a brief statement describing the focus of their study.

Step 3: Describe the Plan of the Study: Students should identify the variables that will be important to monitor in the study. Given the variables and the research questions, the students should describe the plan they intend to use to carryout their study. The plan can be an outline of the steps they will follow in their study. A checklist is helpful for students, especially as they work on carrying out their study. (See Figure 10)

At this stage, you may want teams to post the description of their study on the network in the gtp.earthconf, especially if they are doing a study that seeks collaboration from other cities or countries. It is important to note that if your students are seeking collaboration from others, you must take the responsibility to *check the network daily* to:

- identify teams of students who do indeed wish to work with your students
- respond to students in other schools who are looking for research partners

Step 4: Carryout the Study: Students should conduct the study, which may involve contacting other students on the telecommunications network and asking for help in collecting data at remote sites. It may also mean going to monitoring sites during the day, or taking equipment home to collect data at night or on the weekends. During this step students will be involved in a number of activities:

- monitoring the variables in their study
- checking with the Global Thinking network conferences regularly
- reading fact sheets, articles and books on the topic
- checking with other conferences on EcoNet. For example another conference they might check is en.climate.
- writing letters or making phone calls to organizations for information about the topic

Step 5: Analyzing the Data: Students should organize their information in a systematic manner. This might involve the use of data tables, graphic analysis, and discussions within small teams and the teacher. Some teams may need to collaborate with peers via the network. The results of the study should be analyzed in preparation for the development of a final report. Please note: if your students collaborated with another group, make sure they send the data to the team(s).

Step 6: Writing to the Network and Preparing Reports: Students should write a brief report (summary of the data, as well as conclusions and recommendations) of their project. The students should file their report in the network conference: gtp.earthconf.

At the local level, you might want your students to display their work as a "poster report." At science and social science research meetings, the poster reports is an interesting way for researchers to share the results of their work. The informal character of "poster reports," promotes interaction among researchers. We encourage you to use this model with your own students.

Poster reports should be visually interesting. They should be produced on large sheets of poster board. If students collected environmental samples (particulates, for instance), they should be included. The poster should include the description of the study, the procedures used, data (data tables, graphs, actual samples), summary, conclusions and recommendations.

Student "poster reports" would be team reports, and would be similar to a mini-science fair. The poster reports could be set up around the room. The communicator could be the spokesperson for the group, enabling the other team members to visit the other poster reports around the class. After you conduct this session in your class, the posters could be put on display elsewhere in the school.

Figure 11
Global Thinking Project
Team Planning Checklist

Procedure	Date Completed	Results
Step 1. Brainstorming Questions		
Step 2: Agree on Questions		
Step 3: Describe the Plan of the Study		
Step 4: Carry out Study		
Step 5: Analyze Data		
Step 6: Writing to the Network and Preparing Reports		

4. Explain to the students that each team is to design and carryout a study on air pollution. Some groups may want to design studies that focus only on particulates, while others may study ozone. Some students may suggest combining particulates and ozone. Discuss the possibilities with your students, and call to their attention that if they plan a study that

requires data from other schools, then they will have to use the network as soon as they know what are their needs.

5. It will take the students several days to do their study. Suggest, however, that they plans studies at this stage that require no more than two weeks of data collection. Explain to students that if they expect to involve other schools in their study, that it will take longer. Students on the other end may have to incorporate the work your students are requesting into their own work load. *Patience is a virtue in the use of telecommunications and collaborative research. But so is persistence.*

6. Give each team a checklist (Figure 11). So steps 1 -3 in a single session. You might conduct a whole class brainstorming session and write questions on a large sheet of paper that students think would be interesting to investigate. Then have each team look over the list, use it as a basis to develop their own brainstorming list (Step 1). Students should then focus in on one or two questions that they wish to study. For instance, suppose students wanted to investigate the relationship between ozone levels and temperature. A research question might be: What is the relationship between ozone levels and air temperature? Students might select a single site, and gather ozone and temperature data over several days. Such a plan might result in data as shown in Figure 12.

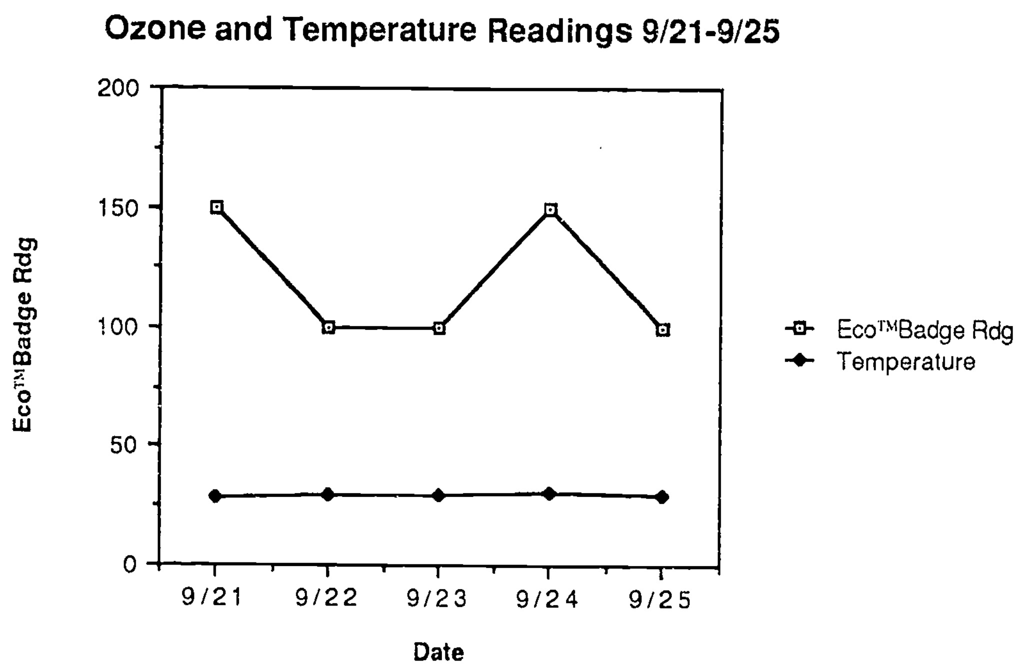


Figure 12. Sample data from study investigating the relationship between ozone levels and temperature

As soon as teams have agreed upon the question(s) for their study, they should describe the plan of their study. The tracker, with the help of other members the team, should write a brief description of their plan, including the research questions, and the method for carrying out their study. These descriptions should be sent to the network and filed in the gtp.earthconf. This is also the time when teams that wish to seek research partners in other schools should sent their messages. Send your requests to other schools in your Global Community.

7. The actual carrying out of the studies will vary from one Global Thinking class to another. However, you should not leave the data gathering to chance. Provide time during class time for data collection, and/or meet with each team to make sure you know how and when they are collecting data. Check the network for data that might be posted for teams seeking collaboration from other schools in your Global Community. Collaborative studies can lead to interesting projects. Figure 13 shows one such possibility.

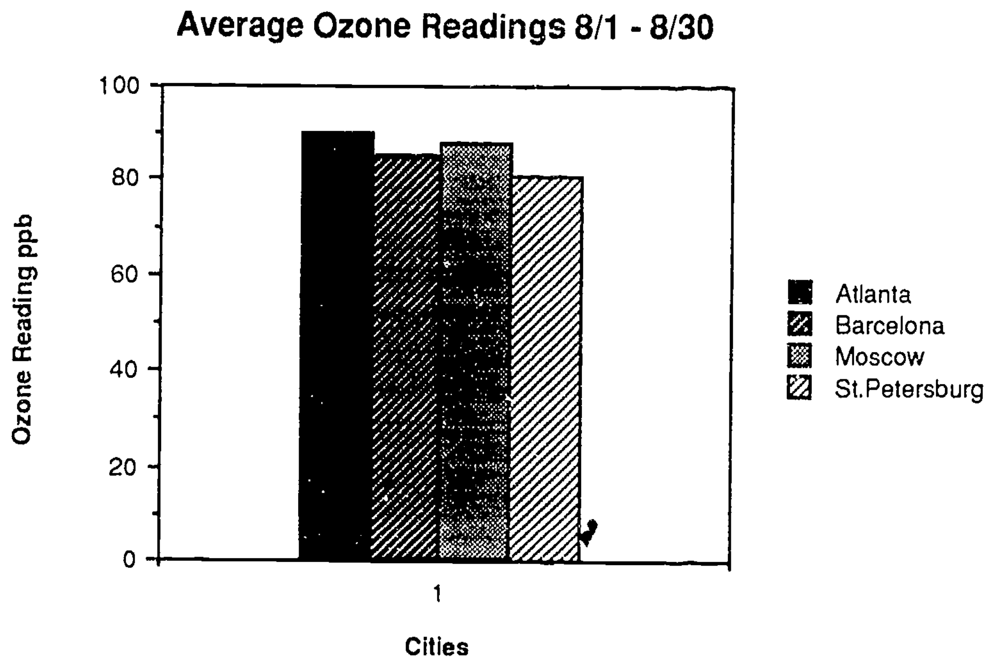


Figure 13. Data from resulting from collaboration of students from three countries

8. Students should analyze their data and begin to prepare their reports for the network. Students may need equipment and materials (balances, graph paper, access to computer graphics programs) to analyze their data. Provide class time for student teams to work together to analyze their data, and prepare their reports.

9. Communicators should send their team's results to other schools in your Global Community. When sending air quality data, use the following formats for sending the data. When you write reports using ALICE it will be advantageous to send the data in a form that can easily be used by the classes reading your data. One way to do this, is to send the data using an agreed upon format. To send air quality quantitative data, your students should use the following format (explanations follow). The same should be done for air quality qualitative data.

Quantitative Air Quality Format:

<ozone>, <temperature>, <wind speed>, <wind direction>, <precipitation>, <latitude>, <longitude>, <school name>, <town name>, <date>

Explanations: Quantitative Air Quality Data

Ozone	parts per billion
Temperature	°Celsius
Wind Speed	km/hour
Wind Direction	compass heading in degrees
Precipitation	cm
Latitude	hh:mm N or S
Longitude	hh:mm E or W
School	name
Town	name
Date	day-month-year

Sample Quantitative Air Quality Data:

```
Air quality data:

150, 28, 5, 165, 0, 34:00 N, 84:00 W, Rocky Mount, Marietta,
20-Oct-93
```

Explanations: Qualitative Air Quality Data

Ozone	Good, moderate, unhealthful, 1st stage alert
Temperature	hot, warm, cool, cold
Humidity	high, average, low
Clouds	cloudy, partly cloudy, no clouds
Sunshine	sunny, mainly sunny mainly clouds, cloudy
Wind Speed	Strong, medium, light, zero
Wind Direction	North, East, West, South
Precipitation	Rain, Drizzle, snow/sleet, none
Particulate count	High, moderate, low

Sample Qualitative Air Quality Data

```
Air quality data:

     moderate, hot, high, no clouds, sunny, light, south,
none
```

10. As other Global Community schools send data to your class, you might want to add it to a Global Community Data Table using the ALICE Software. To make the data more visual to everyone, prepare the Global Community Air Quality Data Table on a large poster. As data arrives, it should be added to the table.

11. Culminate the work on Project Air Quality by having each team prepare a poster report of their work. The poster reports should summarize and visually show the results of their work. Poster reports will first be displayed and used in class, then put on display elsewhere in the school.

Optional Extensions

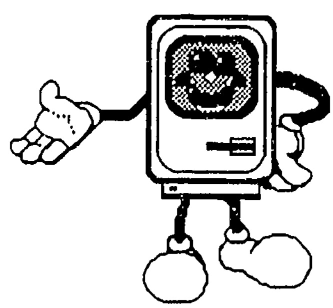
1. Have the students write an editorial letter or report of their study, and the implications for the local community, and sent it to the local newspaper.

2. Have the students create a scrapbook of articles on pollution (don't limit them to air pollution).

3. Make contact with a local environmental action group and let them know that they are working on global problems. Students can send the local group a copy of their report, and encourage the group to visit their class.

4. Start a Global Thinking Ecology Club. Students can meet to discuss the idea, then create a charter, and begin a series of activities focusing on the local environment.

5. Contact Gaia and report the results of the class's work on Project Air Quality



GAIA

Notes

Project
Global Thinking

Once a photograph of Earth
taken from the outside is available,
an idea as powerful as any in history
will let loose.

Fred Hoyle, British astronomer, 1948.

Goals of Project Global Thinking

1. Students will explore and enhance their own concept of what constitutes global thinking.

2. Students will expand their awareness of the interconnectedness of planetary systems.

3. Students will identify and evaluate local and global ecological problems.

Planning Chart: Global Thinking

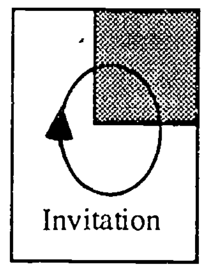
Activity	Title	Telecommunications Alert	Time Allotment
1	What is Global Thinking?	Yes	1 session
2	Interrelationships	Optional	2 sessions
3	Human Wants and Needs	Yes	1 session
4	Global Problems	Yes	1 session

What is Global Thinking?

In this activity, the students explore their initial notions of what the term "global thinking" means. They formulate an operational definition of "global thinking" which will be subject to modification and refinement throughout the remainder of this project.

Objectives

• The students will develop an operational definition of global thinking.



Materials

photograph of the Earth taken from space
flipchart
markers
(1 copy of Attachment 1 per team for Optional Extension 2)
(World map for Optional Extension 6)

Procedure

1. Open the lesson by writing the following sentence on the board: "We all live downwind". Allow about 5 minutes for teams to discuss what they think this sentence means.

2. Show the students the photograph of the Earth from space that appears on the cover of this Teachers' Guide. Ask each team to make a list of statements that answers the question, "What is global thinking?".

3. When students have finished, have reporters take turns reporting one statement at a time from each team's list. One or two student recorders can write the statements on flipcharts, so they can be posted in the classroom.

4. Review the list with the students. Assist the students in distinguishing between global thinking and global problems. Edit the list of statements as necessary to remove references to global problems (these will be addressed in a later activity). Remind the students that this operational definition of global thinking may be modified at any time if their ideas change. Invite students to add additional statements to the list now, or at any time in the future.

Optional Extensions

1. Invite student teams to construct a diagram (concept map) that shows what global thinking is (Figure 1). Post these around the classroom for all students to view. Have a reporter from each team share the diagram with the class.

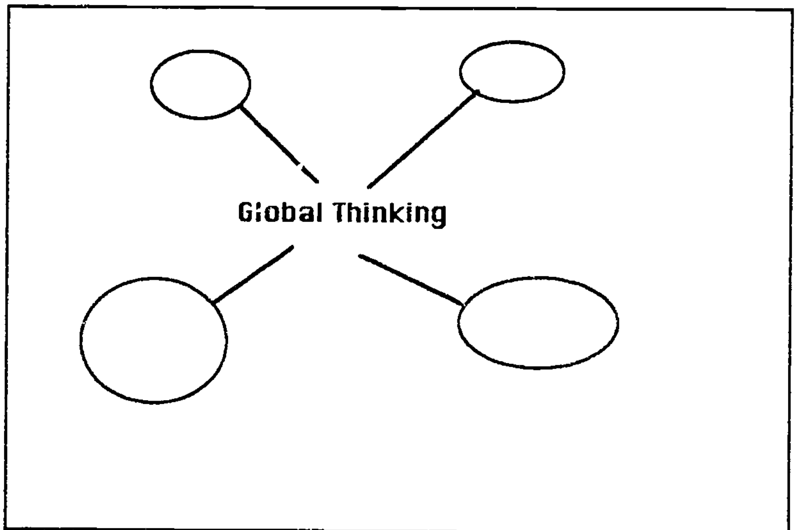


Figure 1. Concept Map Template

2. Study the attached quotations from astronauts who have viewed the Earth from space (Figure 2). What elements of these astronauts' thinking are found in your class' list of global thinking statements? Are there any other new ideas? Add them to your list. Discuss them in light of the quotation from Fred Hoyle that began this section.

3. Compare and contrast your class' findings with those of students in other classes. Send your list of statements the schools in your Global Community and to the gtp.earthconf, and obtain one from another school in your Global Community. Why do you think differences and similarities exist? How different do you think they would have been when your parents were your age? Why?

4. As a class, develop a questionnaire to assess the extent of global thinking in younger or older students, or adults in the community. Develop a strategy for collecting and analyzing the data obtained from the survey, and for sharing the results with other schools in your Global Community. Send your invitation to each school in your Global Community and post it in the gtp.earthconf.

5. Create and maintain a "global thinking" bulletin board (see Chapter 2). Invite student suggestions of types of information they are interested in plotting on a map of the world (for example: earthquakes, floods, hurricanes, storms, wars, population trends). Ask for suggestions of other items the students think should be included on the bulletin board. Organize students into small groups based on interest in a particular topic, and make these groups responsible for collecting information about their topics. Create a bulletin board subcommittee comprised of one member from each group to be responsible for maintaining the bulletin board and updating it on a weekly basis.

6. Assign each team a continent or bioregion. Teams should select a country in their continent or bioregion, and research its imports, exports, and trading partners. On a map

of the world, connect each country with its trading partners (red string for exports, blue string for imports). Discuss as a class how economic interdependence is related to the global thinking concept.

"For those who have seen the Earth from space, and for the hundreds and perhaps thousands more who will, the experience most certainly changes your perspective. The things that we share in our world are far more valuable than those which divide us." (Donald Williams, USA)

"After an orange cloud-formed as a result of a dust storm over the Sahara and caught up by air currents-reached the Philippines and settled there with rain, I understood that we are all sailing in the same boat." (Vladimir Kovalyonok, USSR)

"...During the eight days I spent in space, I realized that mankind needs height primarily to better know our long-suffering Earth, to see what cannot be seen close up. Not just to love her beauty, but also to ensure that we do not bring even the slightest harm to the natural world." (Pham Tuan, Vietnam)

"From space I saw Earth-indescribably beautiful with the scars of national boundaries gone." (Muhammad Ahmad Faris, Syria)

"Before I flew I was already aware of how small and vulnerable our planet is; but only when I saw it from space, in all its ineffable beauty and fragility, did I realize that humankind's most urgent task is to cherish and preserve it for future generations." (Sigmund Jahn, GDR)

"The first day or so we all pointed to our countries. The third or fourth day we were pointing to our continents. By the fifth day we were aware of only one Earth." (Sultan Bin Salman al-Saud, The Kingdom of Saudi Arabia)

"...We are one world." (John-David Bartoe, USA)

Figure 2: Quotations from astronauts who have viewed the Earth from space[1].

[1](Kelley, K.W. (ed.) 1988. *The Home Planet* (New York: Addison-Wesley Publishing Company and Moscow: Mir Publishers)

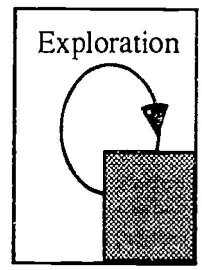
PROJECT Global Thinking — Activity 2:

Interrelationships

The purpose of this activity is to begin to develop the idea that the Earth is comprised of a number of interrelated systems.

Objectives

• The students will develop a model representing the major interrelationships between the Earth's resources and living things.



Materials

Our Planet Our Home Learning System, or

Cardboard circles, crayons or markers, and yarn or string

(Teachers may obtain the Our Planet Our Home Learning System (OPOH) for $39.95 from Zephyr Press, P.O. Box 13448-J, Tucson, AZ 85732-3448. The kits contain enough materials for three teams. Those who do not have access to these materials may conduct the activity using yarn or string and 8 cardboard circles per team on which students have drawn representations of the sun (heliosphere), water (hydrosphere), earth (lithosphere), air (atmosphere), biosphere, plants, animals, and humanity.)

Procedure

1. Using the laminated cards provided in OPOH or the cards that you have made (see materials list) introduce the components of the ecosystem: heliosphere (sun), hydrosphere (water), atmosphere (air), lithosphere (earth), and biosphere (plants, animals, humanity). Give a set of the laminated cards to each team, and ask them to use the arrows provided to show how they think these components are related (Figure 3).

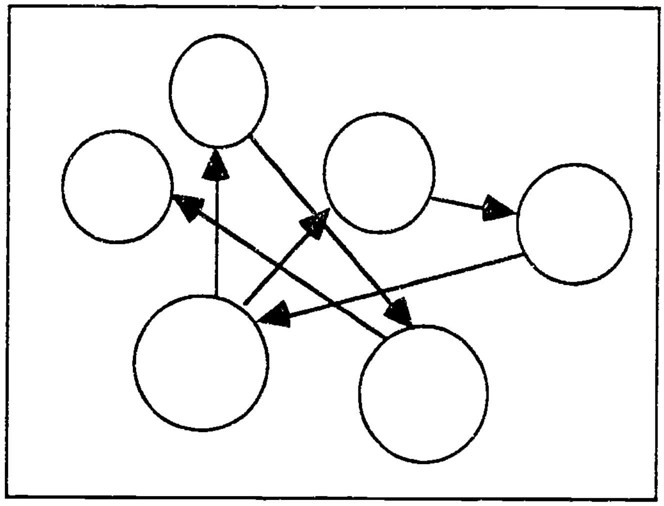


Figure 3. Hypothetical Relationships Among Elements of the Ecosystem

Allow time for teams to share their models with each other.

2. Use the JIGSAW method to explore the four resources of the planet: sun, water, air and earth.

Assign team members to one of four "expert" groups.

Assign each "expert" group one of the resources to study.

Using what they already know and any reference materials they may have available, "expert" groups should compile information about their resource, including, but not limited to:

What is it, and what is it comprised of?
What animals and plants live in it?
Make a list of things that need your resource. What kinds of uses is it put to by living and non-living things (directly and indirectly)?
What would the Earth be like without it? (draw a picture)

3. Allow time for "experts" to share the results of their discussions/investigations with their respective teams.

4. Encourage teams to experiment with their earlier models by removing different components from the system. What happens if you remove water, for instance? Plants? People? (!).

Optional Extensions

1. Produce a drawing illustrating resource interrelationships and an accompanying written rationale, and share these with students in another Project school. Obtain a copy of theirs, as well. Discuss points of agreement and disagreement. Do cultural differences seem to make any difference? Send a message to schools in your Global Community to locate partners for this activity.

2. Read and report in detail on the Gaia hypothesis. Find a creative way of reporting your findings to your class and to other Project schools. Send your results to Gaia!

3. Write and perform a skit illustrating the interrelationships you have discovered.

4. Create a piece of art work (drawing, painting, collage, music) to express the interrelationships you have discovered.

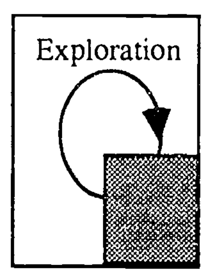
Many more ideas for extending this activity can be found in the Teachers' Guide which accompanies the OPOH Learning System.

PROJECT Global Thinking Activity 3

Human Wants and Needs

In this activity, students examine their own perceived wants and needs in the context of the Earth's limited natural resources.

Objectives



• The student will distinguish between human wants and needs.

• The student will rank order a list of human wants and needs, and compare and contrast these rankings with those of students from other schools.

• The students will relate satisfaction of human wants and needs to the consumption of natural resources.

• The students will develop an understanding of the interconnectedness between human wants and needs and the life systems of the planet.

Materials

flipchart
markers

Procedure

1. Open the lesson by reading the following scenario to your students:

> *Imagine that you are about to leave for a two-year stay in a space station orbiting the Earth. Make a list of all of the things you would take with you for this voyage.*

In teams, ask the students to brainstorm lists of things they would take on the trip.

2. After about 10 minutes, introduce the terms "want" (nice to have, but you don't need it to survive) and "need" (necessary for survival). Instruct the teams to go back and label the items on their lists as wants ("w") or needs ("n").

3. Collect class lists of wants and needs by asking team reporters in turn to tell you one want or need. (You can have two student recorders writing on two sheets of newsprint, while you conduct the discussion).

Edit the lists by combining any items that are similar. Invite students to add any wants or needs that have been omitted. You may also wish to suggest additions at this point.

4. Provide each student with a copy of the final list of basic human needs. Instruct the students to work alone as they rank order the needs from most (#1) to least important.

5. Have students meet with their teams to agree on a consensus ranking of the human needs, and to develop a rationale for their ranking.

Allow time for a spokesperson from each team to share their rankings and thinking with other members of the class.

6. Ask the students how humans satisfy these needs. (i.e., where do their food, clothing shelter come from?) After allowing brainstorming for a few minutes, continue in teams to complete the following activity:

Instruct each team to select the most important human need from its list, and identify all the natural resources required to satisfy that need. For example, if a team chose food as its most important need, it might proceed in the following way:

List all the foods you ate yesterday. Separate these foods into those that came from plants and those that came from animals (if an item came from both, or from several sources, break down that item into its components). Identify all of the resources required to produce these foods.

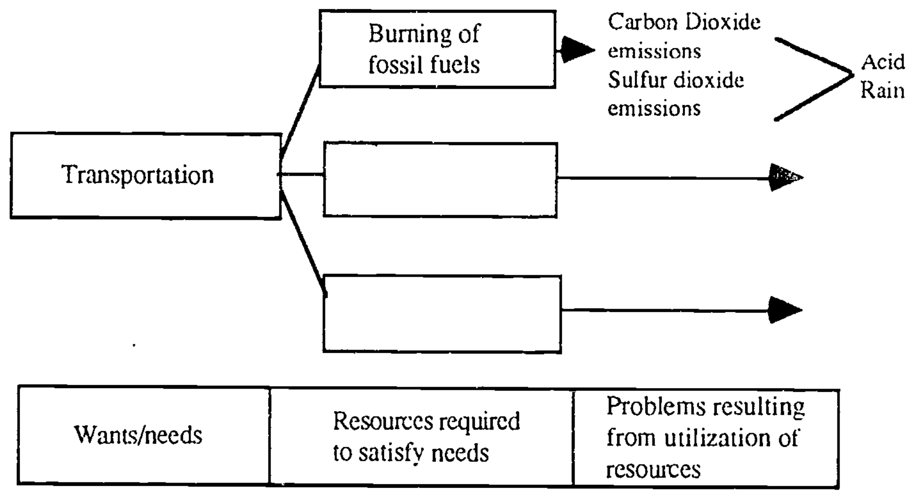
7. Ask a spokesperson from each team to present its list to the class.

Invite the class members to look for similarities in the diagrams, i.e., where do they all end up? (all will go back to food, energy, air, water, earth)

Conclude with the thought that we are dependent on the life systems of the Earth to satisfy our basic human needs. (So, we'd better take care of them!!!)

Optional Extensions

1. Explore the question of how satisfaction of basic human needs is related to global environmental problems by creating a tree diagram relating wants/needs to resources and problems resulting directly and indirectly from the utilization of these resources (see example below).



2. Investigate what is meant by eating lower on the food chain. Evaluate whether or not this idea makes sense to you in the context of what you discovered doing this activity.

3. Create a piece of writing, a work of art, a piece of music, or a play to share your understanding of interconnectedness with others in your community.

4. Collect information from other classes in your Global Community that will help you evaluate how your perception of human wants and needs is similar to or different from theirs.

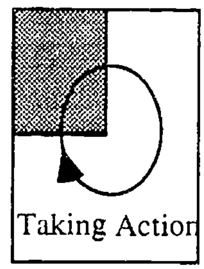
5. Conduct studies of wants/needs rankings by students older or younger than yourselves. Are there any differences? Are there any differences when you look at boys vs. girls? Do adults have similar or different perspectives. Produce a research report that can be shared with other schools in your Global Community. Try to get your study published in a science teachers' journal, or in a local news publication.

PROJECT Global Thinking Activity 4

Global Problems

What are some of the problems that the planet faces today? How are these problems perceived by students in different communities and nations? The twelve problems identified in this activity have been identified in a recent research study as critical problems that need to be discussed and acted upon.

Objectives



• The students will rank order global problems.

• The students will discuss the significance of global problems, and reflect upon the opinions of others.

• The students will make predictions about the future of global problems.

Materials

flipchart or blackboard
Global Problems Cards (Attachment 4, 1 set per team)
Questionnaire (Attachment 5, 1 copy per student)

Procedure

1. Begin by asking the class, "What are some environmental problems facing the Earth today?" Write these on a flip chart or on the board.

2. Present the global problems cards (Figure 4), explaining that these problems have been identified in a research study as critical problems that need to be discussed and acted upon. Give each team a set of cards.

3. Allow students in teams to discuss with each other what they know about each of the global problems represented on the cards. Then teams should rank order the problems from most to least important. Each team should reach consensus on a ranking of the global problems. After each team has rank ordered the problems, they should discuss the reasons for their group's decision. All group members should be prepared to defend their ranking. Record the team's rankings of the global problems on a sheet of paper.

4. Allow time for one member of each team to present the team's rankings to the rest of the class. Post the rankings in the classroom.

5. Distribute copies of the questionnaire How Will Global Problems Change by the Year 2020? (Figure 5) Each student should complete the survey, indicating how he/she thinks each problem will change between now and the year 2020.

6. After each team member has responded individually to the questionnaire, teams should meet to reach consensus on how it thinks the problems are likely to change. Each team should design a way of collecting and presenting the team's responses to the global problems questionnaire. Students may design graphs, charts, and/or posters present predictions to the rest of the class.

Optional Extensions

1. Organize a class conference on global environmental problems.

What would students recommend, given the following problem statement:

> *The Earth is faced with a number of serious environmental problems: global warming, ozone depletion, acid rain, and depletion of rain forests, just to name a few. What is the most serious problem facing the Earth? How does this problem relate to the others? What needs to be done over the next ten years to help resolve this problem?*

Allow each team to make a brief presentation on what it thinks is the most serious problem facing the Earth. Develop your own class charter on the resolution of global problems. Solicit reactions and input from other classes in your Global Community.

2. Administer the Global Problems questionnaire to other groups in your community. How are their responses similar and different from yours.

3. Obtain rankings of global problems from students in other schools in your Global Community. Are there any differences or trends that emerge? Are any of these attributable to location, culture, age, course of study, or any other variable? How do girls' and boys' answers compare?

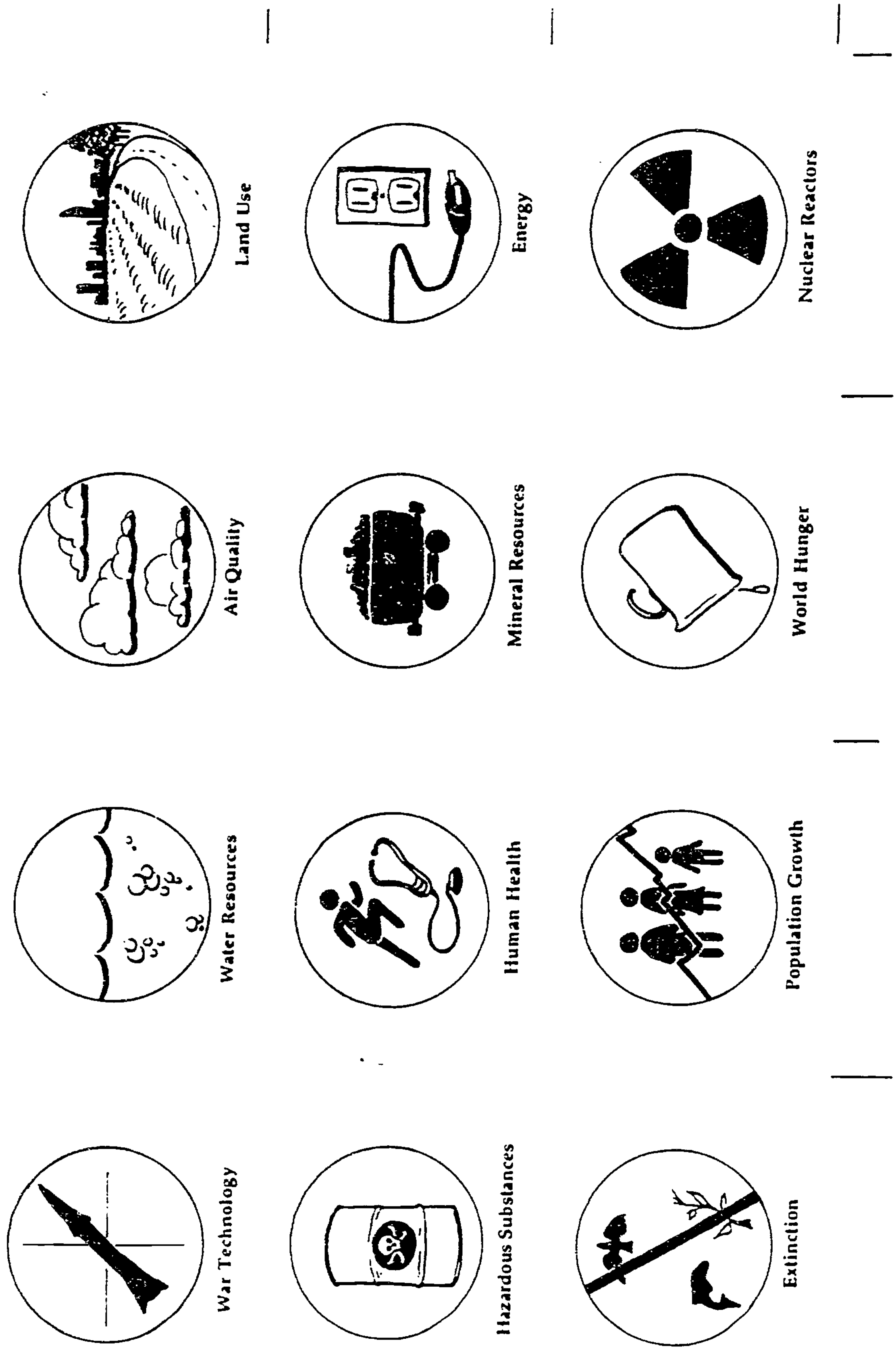
4. Explore ways, other than rank ordering, of depicting the relationships among the global problems. Can they be webbed? Clustered? Are there a few that are really primary (or causes of the rest)? Try to write out or diagram your ideas, and share them with other teams.

5. Identify and research the major environmental problems of your town or region. Interview citizens, community leaders, and/or students to determine their knowledge of these problems, and points of view. Collect these interviews on tape, video, or in writing, and share them with decision-makers.

6. Explore the UNCED resolutions, and the controversies surrounding them. How do the wants and needs of particular countries affect deliberations of this sort? Collect newspaper accounts of this conference from different cities and countries. How did the coverage differ? Why?

7. Design and conduct a study to determine the level of awareness of global environmental problems among different groups (age levels, educational, professions, etc.) in your community. Get another class in another school to collaborate with you, so that you can compare results.

Figure 4. Global Problems Cards.



121

120

Figure 5. Questionnaire: How will global problems change by the year 2020?

Population growth (world population, immigration, carrying capacity)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

War technology (nerve gas, nuclear developments, nuclear arms threat)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

World hunger and food resources (food production, agriculture, cropland conservation)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Air quality and atmosphere (acid rain, carbon dioxide, depletion of ozone, global warming)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Water resources (waste disposal, estuaries, supply, distribution, ground water contamination, fertilizer contamination)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Land use (soil erosion, reclamation, urban development, wildlife habitat loss, deforestation, desertification)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Energy shortages (synthetic fuels, solar power, fossil fuels, conservation, oil production)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Hazardous substances (waste dumps, toxic chemicals, lead paints)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Human health and disease (infectious and noninfectious disease, stress, diet and nutrition, exercise, mental health)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Extinction of plants and animals (reducing genetic diversity)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Mineral resources (nonfuel minerals, metallic and nonmetallic minerals, mining, technology, low grade deposits, recycling, reuse)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Nuclear reactors (nuclear waste management, breeder reactors, cost of construction, safety)
____ much better and better ____ about the same ____ worse and much worse ____ don't know

Global Thinking Notes

Project Solid Waste

Every year we create more waste.
Every year there's less space to put it.

The 1992 Information Please®Environmental Almanac

Goals of Project Solid Waste

1. Students will become familiar with the terms and concepts associated with disposal of non-toxic solid waste.

2. Students will explore the extent of the solid waste disposal problem on a local and global level.

3. Students will identify and evaluate various means of solid waste disposal.

4. Students will suggest viable solutions to the solid waste disposal problem.

5. Students will network with other schools that are part of the Solid Waste Global Community. Networking activities will include sending other schools data on the composition of the waste stream, analyzing other schools solid waste data, and engaging in collaborative projects.

Planning Chart: Project Solid Waste

Activity	Title	Telecommunications Alert	Time Allotment
1	Getting to Know Your Trash	Yes	2 sessions, Plus data collection overnight
2	The 3R's: Reduce, Reuse, Recycle	Yes	2 sessions, Plus data collection overnight
3	How Long Will It Be There?	Yes	2 sessions, Then 10-15 minutes periodically, for the next few months
4	Evaluating Waste Disposal Options	Yes	3 sessions

Note: If you implement Project Solid Waste in your class, you will become a member of the GTP Solid Waste Community. You should create a new "group mailing list" in your ALICE Network software address book. You will be sent the schools participating in the

Solid Waste Community by the Global Thinking Project Headquarters. You will probably have some schools new to your students, and if that is the case, you might want to send them a **Hello Packet** as you did in Project Hello.

PROJECT Solid Waste Activity 1

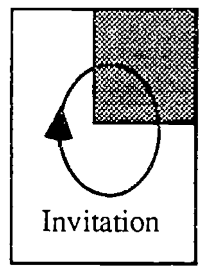
Getting to Know Your Trash

In this activity, students classify and measure the solid waste materials produced by their families.

Objectives

• To develop a classification system for the solid waste produced by a family.

• To classify and measure the solid waste output of a family.



Materials

flipchart or blackboard
Household Waste Survey (Figure 1, 1 copy per student)

Procedure

1. Begin by asking students to name some things they threw out after lunch today (list on board or chart paper). Then ask them to add to the list things that were thrown out in the process of preparing their lunches.

2. Assist the students in classifying the different kinds of trash. What other kinds of things do we throw out at home? (add other types of trash to the list.)

3. Ask students in teams to generate a list of questions they have about household solid waste. Post each team's questions on chart paper around the room.

4. Conduct a class-wide investigation of household solid waste output using the Household Waste Survey included in this activity (Figure 1). Students will need to separate and weigh (on a bathroom scale at home) their family's output of different waste categories for one day.

5. Ask teams to compile their individual data to determine an average daily output per person for each category. Teams may present these findings in charts, tables or graphs.

Household Waste Survey

1. For each category, record the weight of garbage you collected. Add to get the total daily garbage output of your family.

2. Compute the percent of the total weight contributed by each category.

Category	Mass of Garbage	% by Mass
Paper and paperboard		
Metals		
Glass		
Plastics		
Rubber and leather		
Textiles		
Yard wastes		
Food wastes		
Other		
Totals		

Figure 1: Household Waste Survey

Optional Extensions

1. Invite teams to explore other questions they have about the composition of household solid waste. Additional questions which may be explored by teams may include the following:

> What is the average yearly output per person?
> Based on these data, what would you estimate the average yearly output of your city or town to be?
> What volume of space would one person's yearly solid waste output occupy in a landfill? The city's?
> Based on predicted population figures for your city, project the solid waste output 10 years from now, assuming waste continues to be produced at the same rate.

Provide class time for teams to present their findings to each other.

2. According the 1992 Information Please Environmental Almanac (Boston: Houghton-Mifflin Company, pp. 108,109), The average daily solid waste generated per person in the United States in 1988 was 4.00 pounds. Of this, approximately 1.50 pounds were paper, .25 pounds were glass, and .30 pounds were plastics (the remainder was in other categories). How do your class data compare with these data? If your data are significantly different, speculate about why.

3. Exchange survey results with students in the Solid Waste Community. How do the results compare? How do your results compare to the data shown in Figure 2: Waste in Major Cities.

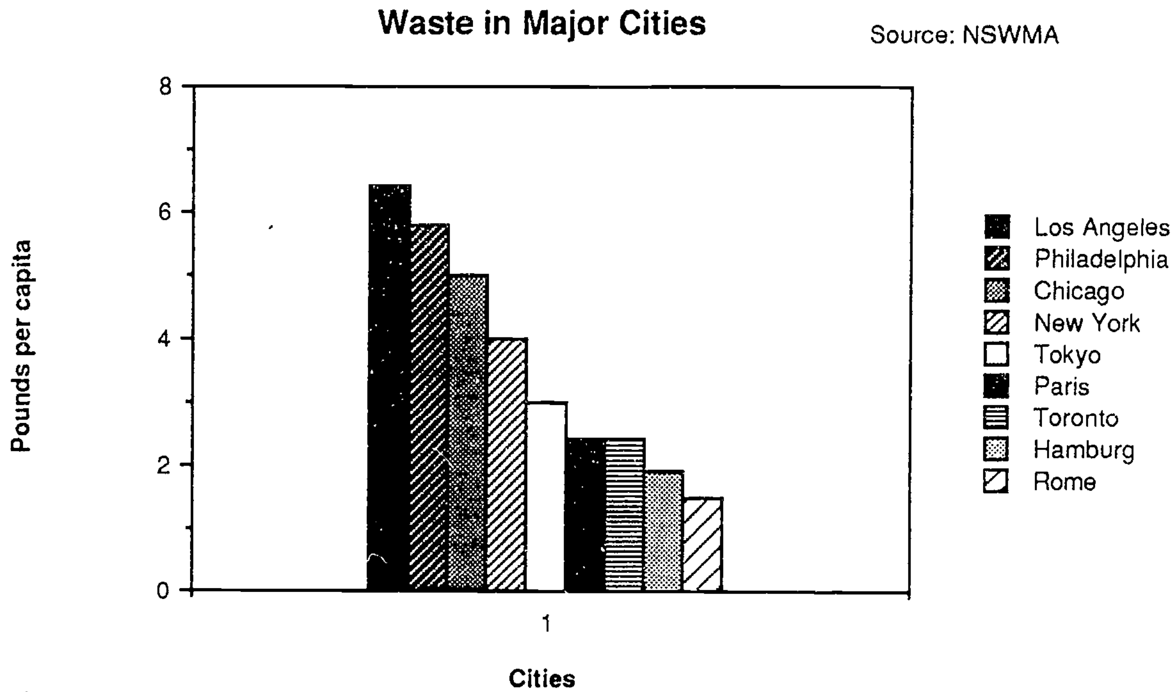


Figure 2. Waste in Major Cities.

4. Observe your neighborhood for evidence of solid waste disposal problems. Inventory the trash in a small area, or create a photographic montage of clean and littered areas in your neighborhood. Share your findings with civic leaders.

5. Using data gathered from reference books, make a map showing waste production/disposal patterns all over the world. Are there any patterns? (See Figure 2)

6. Cooperate with another school to launch a trash reduction project.

The 3 R's: Reduce, Reuse, Recycle

In this activity, students explore how the 3R's of solid waste disposal could help reduce their own family's solid waste output.

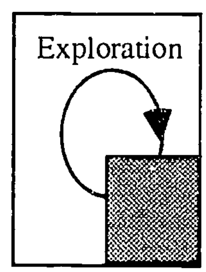
REDUCING solid wastes means decreasing the number and volume of discarded products. This includes reducing the amount of unnecessary packaging, and reducing the amount of toxic chemicals in these products.

"Recycling" means that the consumer purchases long-lasting, REUSABLE items, rather than disposables.

If properly treated, aluminum, batteries, corrugated cardboard, clothing, glass, paper and cardboard, plastics, oil, tin and steel cans, tires and yard wastes (including Christmas trees) can be RECYCLED. (*1992 Information Please Environmental Almanac*, pp. 123,4)

Objectives

• Students will identify ways that they could reduce their own production of household solid waste.



Materials

Materials will vary
(1 copy of newspaper articles per group for Optional Extension 1)

Procedure

1. Begin by asking the class whether they have heard the terms REDUCE, REUSE, RECYCLE. Ask students to explain what they think each word means in relation to solid waste disposal.

2. Have students look at the lists of things they threw away at lunch yesterday. Explain that the goal of today's lesson is to discover ways to decrease the amount of trash they throw away. Spend about 5 minutes having students brainstorm ways they could reduce the trash from their lunches.

3. Assign one team to conduct each of the investigations below, and to report its findings to the class.

a. What's in your purse/pocket/desk/lunch box (tray)? What items do you have in your possession right now that could be replaced with a reusable alternative (Kleenex, disposable pens, etc.). Conduct a similar survey in your home.

b. Identify items in your household trash that can be RECYCLED. What is the weight of these items? Brainstorm lists of ways you could decrease the number of items discarded by recycling. Using figures from your team, estimate how much these recycled materials would be worth per year. According to the U.S. Environmental Protection Agency, the average prices in dollars per ton of some common recycled materials are as follows (Figure 3): cardboard boxes, 35; newspapers, 10; white paper, 45; aluminum cans, 1050; steel, 55; glass, 40; clear plastic soda bottles, 120)

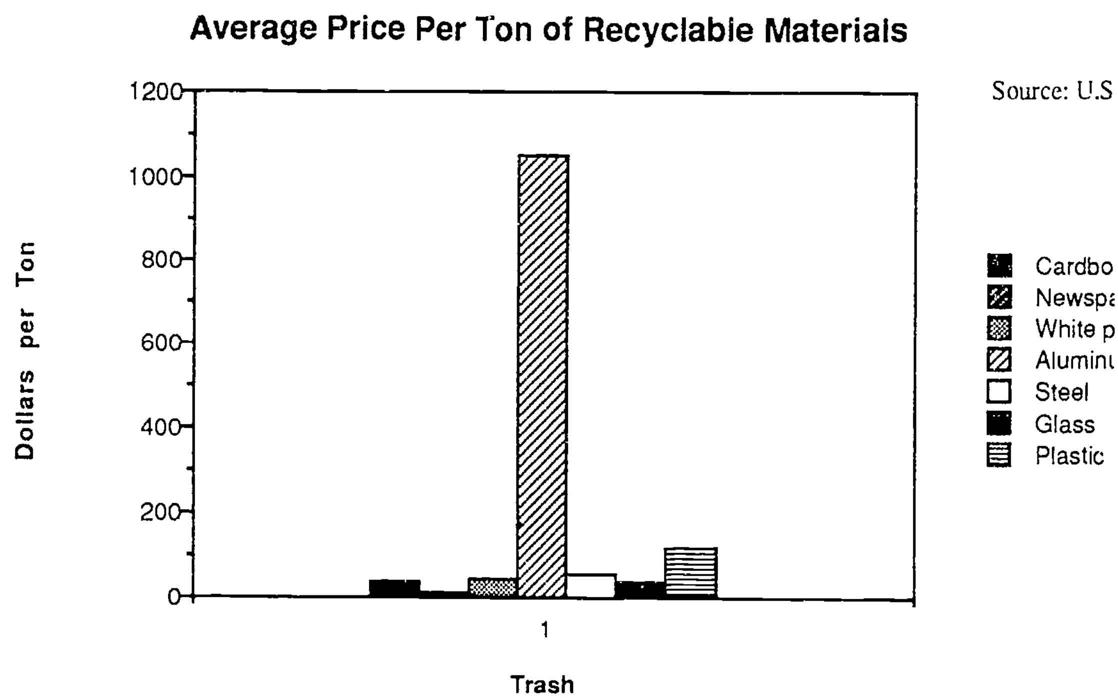


Figure 3. Average Price of Recycled Materials.

c. Conduct a survey in a grocery store: find examples of "over packaged" products, and their alternatives, or survey your homes for examples of environmentally friendly or unfriendly choices in packaging.

d. In your team, brainstorm causes of the solid waste problem. Use these ideas to help you design and conduct a consumer survey to assess consumers' perceptions about the cause of the solid waste problem.

Optional Extensions

1. Conduct a class debate using the USA today articles that follow this section.

2. Compare and contrast the results of your teams' studies with other schools in the Solid Waste Community.

3. Have a "trashless" picnic...challenge each other to bring a lunch that produces no trash.

4. One person's trash is another person's treasure. Sponsor a competition for the most creative reuse of what would otherwise have been a "throwaway." Or give an award monthly for the most innovative suggestion for one of the three R's.

5. If there is a curbside recycling program in your community, find out as much as you can about it (cost, volume, what is recycled, level of acceptance, etc.)

Waste Management in the News

The Garbage Glut is Everyone's Business

Source: USA Today, November 17, 1989)

Garbage just won't go away.

And we can't ignore it anymore.

There are fewer and fewer places to dump it.

The "pooh pooh choo choo"-5,000 tons of sewage sludge-is chugging its way back to Baltimore after a month-long trip, first to Donaldsonville, La., where residents turned up their noses, then to Moss Point, Miss., where the welcome mat was also yanked.

Five train cars of rotting refuse from Philadelphia headed for Brazil, Ind., met the same fate last month. A court order turned it around and sent it back home.

And in Los Angeles, trash trucks hustle from one dump to another, trying to find one that hasn't taken in its daily quota. Unless something is done by 1992, the city will be turning out 6,000 tons of garbage a day with no place to put it.

Across the USA, city and county officials are longing for the good old days, when the mountains of garbage produced by conspicuous consumption were whisked away, never to be whiffed again.

But garbage that used to be dumped, burned, then buried is now burying us.

Landfills, where most trash winds up, are disappearing at an alarming rate. The Environmental Protection Agency expects that 2,000 of them will disappear within four years.

What's worse, landfills have not proved to be the busy little biodegraders that people expected. They've actually preserved hot dogs and carrots for 15 years; 20-year-old newspapers can still be read.

What can be done? Plenty.

We can produce less trash.

More firms are finding ways to reduce packaging waste. And the federal government has set a goal of reducing garbage production by 25% by 1992.

We can convert more trash to energy.

Tazewell County, Ill., hopes to turn methane gas at its landfill into electricity for 2,400 homes. More communities need to seek ways to convert waste to power.

And we can recycle more of our trash.

Thirty states are implementing laws to separate trash for recycling; 10 have mandatory separation.

The recycling idea is catching on. Two-thirds in a recent poll said they had recycled some garbage.

Minnesota dairy farmers are finding that shredded newspapers make great cow bedding. School cafeterias and fast-food restaurants earn money by recycling plastic foam products. New Yorkers return three-quarters of their bottles and cans for deposits each year, keeping 100 million tons of trash out of landfills.

Such efforts show that individuals can make a huge difference. But the writer across the page thinks the price is too high. He'd rather pay someone else to do his sorting.

The price may be steeper than he thinks. In Woodbury, N.J. he'd pay a fine of up to $500 a day for not sorting his trash. In Hamburg, N.Y., he would forfeit trash pickup.

The price is steep because the consequences are dire: We can be buried in our own refuse if we don't act soon. Ignoring garbage won't make it go away. Dealing with it will.

Its a dirty job, but everybody has to do it.

The Garbage Glut is None of My Business

Harvey Schwartz. Source: USA Today. November 17. 1989

At my age. I don't have the time. the energy or the desire to become a trash man.

All those proposals to have me spend my time sorting trash. putting paper in one pile. glass in another. etc.. leave me cold.

I pay my taxes to have my trash collected. and I expect those who spend my taxes will do their job rather than attempt to draft me into the ranks of their workers. I was drafted in World War II. and that was enough.

If there is a need to have trash sorted. then let the authorities do it. The people who collect my trash can go through it to segregate whatever they want to. If that requires more trash collectors and therefore more taxes. I'll be glad to pay up.

But the idea of trashing my life and making me part of the collection systems has as much appeal as joining East Germany's Communist Party.

What is so special about trash that makes the environmentalists so frenzied about getting all of us involved in the problem?

Nobody ever asked me to teach my kids when they were going to grade school. Nobody suggests I should personally deliver my letters to my correspondents. And no good liberal wants me to get a gun so I can defend my home against burglars and similar lowlifes.

So why do I have to get involved in trash?

If the solution is so desperate that it makes sense to talk seriously about conscripting millions of Americans. then why not move to cut the volume of trash?

Most of trash. for example. consists of newspapers. Every Sunday morning I get about 15 pounds of newspaper deposited at my front door. and that's just two newspapers. Most of those pages are devoted to advertisements for things I have no interest in buying. So why not simply order that no newspaper. daily or Sunday. be allowed to print more than four pages a day? Then I could easily get by on one trash can a week. not four or five. as now.

But. of course. there are similar opportunities in other fields. Think of all the elaborate Christmas wrappings that are going to end up in the trash piles this next month or so. A single law banning all elaborate or special wrapping for packages could do a great deal to diminish the volume of trash and. thus. ease the supposed trash crisis.

I can already hear the counter arguments: My proposals would be acts of dictatorship and would violate the freedom of the press. Horrors. my opponents will say.

But it is precisely the press which is backing the move to draft me to become a trash man.

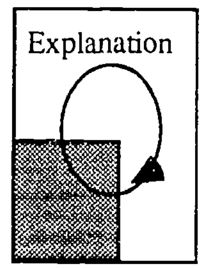
When the press stops urging a dictatorial move against me and my free time. I'll be glad to stop urging the most obvious way to cut the current trash mountain.

Turnabout is fair play. I say.

How Long Will it Be There?

In this activity, students design and conduct a long-term investigation of the rates of decomposition of various types of household solid waste under various conditions.

Objectives



• Students will determine the rates of decomposition in a landfill of various types of household solid waste.

• Students will design and conduct an investigation which demonstrates knowledge of independent and dependent variables and controls.

Materials

examples of household garbage
materials for experiments will vary

Procedure

1. Hold up examples of items found in a typical household's garbage. Ask students to speculate about how long they think it would take for items to decompose. Record their predictions on a piece of newsprint and post them in the classroom.

2. Invite students to ask questions about how and why materials in a landfill decompose, and what factors affect the rate of decomposition.

3. Instruct each team to design an experiment to study the rate of decomposition of one or more types of household trash in a landfill, and/or factors that affect the rate of decomposition. Students may choose to actually bury items in the school yard (about 6 inches deep) and exhume them at later intervals, or simulate "burial" in containers (petri dishes or comparable containers) in the classroom. As each team designs its study, discuss controls, dependent and independent variables, and how they plan to report the results of their experiments to the rest of the class. Emphasize that this study will be conducted over several months, since some items may decay very slowly.

4. When the experiments have concluded, students should compare their experimental findings with their original predictions and report their findings to the class.

5. Combine the class data and make a time line for decomposition of various types of solid waste. Include milestones in students' own lives as a frame of reference. (For example, imagine a bag of trash buried on the day they were born. When the wood decomposes, they will be graduated from high school......)

6. Invite students to explore their feelings at this point about solid waste. Have any students made any changes in their behavior as a result of this project?

Optional Extensions

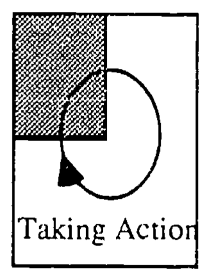
1. Start a project in the community to raise awareness and encourage people to practice the 3 R's. Brainstorm ways to teach what you've learned to members of your community, and encourage them to change their behavior. Each team select one, and follow through on it. Report on your progress on a Global Thinking Project bulletin board, and try to get teams in other schools to join you in your effort.

PROJECT Solid Waste Activity 4

Evaluating Waste Disposal Options

In this activity, students will develop evaluative criteria and evaluate the common options for disposing of non-toxic solid waste.

Objectives



• The student will distinguish between a problem and an issue

• The student will generate a list of criteria (based on values) which can be used to distinguish between alternative solid waste disposal methods.

• The student will evaluate solid waste disposal methods based on evaluative criteria developed in class.

Materials

Decision Making Grid (Figure 4, 1 copy per team)

Procedure

1. Begin by asking students whether they feel that solid waste disposal is an environmental problem

2. Then ask why this problem has become an issue. (This will require that students distinguish between a problem and an issue, which results from disagreement about the solution to a problem.)

3. See whether the students can list the 3 common methods of disposing of non-toxic solid waste: open landfill, sanitary landfill, and incineration. Solicit knowledge of these.

4. Create 3 expert groups to investigate each of the three methods of solid waste disposal. Before the groups begin their investigations, work with the class to develop a list of questions about solid waste disposal methods that they'd like to have answered before evaluating them. Post these questions on chart paper in the classroom. Invite students to add questions as they think of other things during the course of their investigations. Also, discuss possible sources of information for their research.

5. Allow time for each of the expert groups to present the results of their investigation to their teams..

6. Ask the students in teams to discuss the slogan "not in my backyard" (NIMBY). What values do you think a person making that statement holds. What values would a person opposing that viewpoint hold?

7. Use the lists of values generated in the previous discussion to come up with a class list of values that could be used to evaluate solutions to the solid waste disposal issue. Examples might be cost, health hazard to humans, convenience, etc.

Using the decision-making grid (Figure 4), ask students in teams to evaluate open landfills, sanitary landfills, and incineration against their criteria. Each team should come up with what they think is the best solution for their community.

Allow time for teams to present their decisions and rationales to the class.

Alternatives	**Criteria** *					
Open Landfill						
Sanitary Landfill						
Incineration						
Source Reduction						
Recycling						

*Students should generate criteria. Examples might be cost, health hazard, convenience, etc.

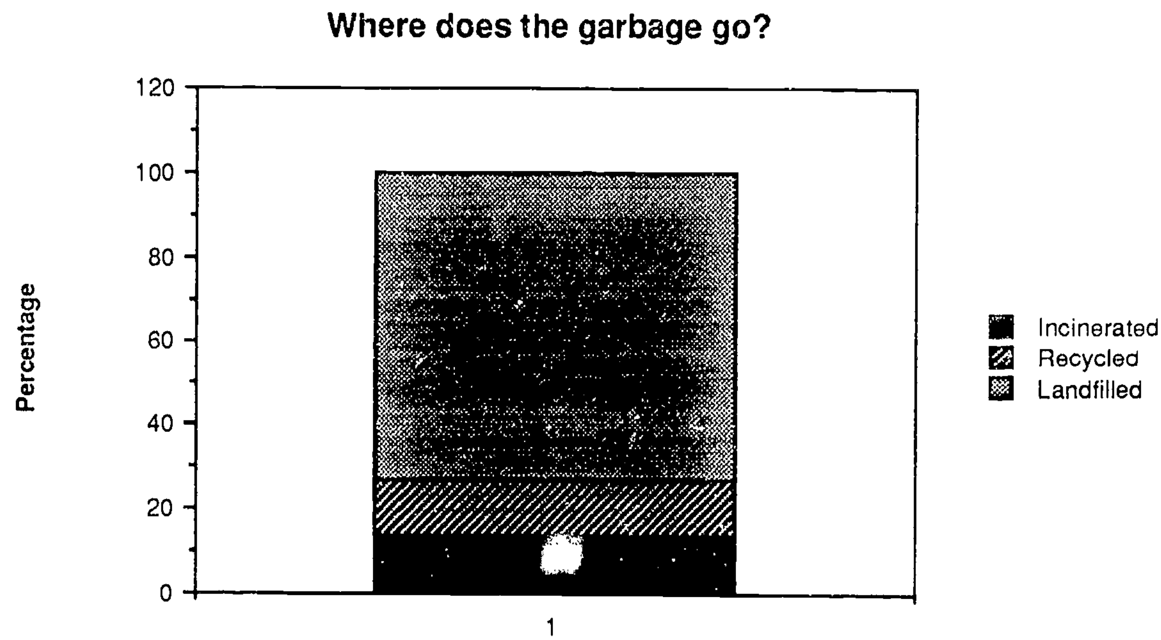
Figure 4. Decision-making grid.

Optional Extensions

1. Discuss opinions and conclusions with students in another school. Compare and contrast their reasoning with yours. Did any values enter into one class' decisions, and not the other's?

2. Discuss with the class ways they could share their opinions with decision-makers. Students may wish to write letters, invite a decision-make to class, stage a public debate, produce a videotape for a PTA meeting, etc. Encourage individual teams to follow through on an action project.

3. Follow your trash - find out where your personal household trash goes when it leaves your house (see Figure 5) (This may involve interviewing the people who pick up the trash in your neighborhood, and asking a parent to drive you to the final destination of the trash.)



4. Gather articles from local newspapers dealing with the solid waste disposal problem in your community. What are the issues? Compare with other schools. Are the issues the same in all communities?

5. Visit an incinerator, landfill or recycling center in your community.

Project Water Watch

My mental boundaries expanded when I viewed the Earth against a black and uninviting vacuum, yet my country's rich traditions had conditioned me to look beyond man-made boundaries and prejudices. One does not have to undertake a space flight to come by this feeling.

धीरे धीरे मेरा मानसिक क्षितिज विस्तृत होता गया... यह भावना और भी प्रगाढ हो गई जब पृथ्वी को मैंने एक सीमारहित, आकर्षणहीन काले शून्य की पृष्ठभूमि में देखा । मुझे इस बात की प्रसन्नता थी कि मेरे देश की सदियों पुरानी समृद्ध परम्पराओं एवं संस्कृति ने मुझे मनुष्य द्वारा बनाई हुई सीमाओं और पक्षपातों से परे देखने के योग्य बनाया है । मुझे यह भी अनुभव हुआ कि एकत्व की इस भावना को महसूस करने के लिए, किसी को अंतरिक्ष में जाने की आवश्यकता नहीं ।

राकेश शर्मा
भारत

Project Water Watch is designed to show your students how to investigate and explore the realm of water on the Earth. The activities can focus on any available body of water such as a pond, lake, creek, or river.

We suggest that you choose a body of water that is located close to your school. If there is a body of water on the school property, we recommend that you use it as the body of water for your students to investigate.

Note: If you implement Project Water Watch in your class, you will become a member of the Water Watch Global Community. You should create a new "group mail list" in your ALICE Network software address book. You will be sent the schools participating in the Water Watch Group by the Global Thinking Project Headquarters. You will probably have some schools new to your students, and if that is the case, you might want to send them a **Hello Packet** as you did in Project Hello.

Goals of Project Water Watch

1. Students will become familiar with their watershed area, the rivers and other bodies of water within it, and possible problem spots.

2. Students will become familiar with the major aquatic macroinvertebrates, their lifestyle, and their role in the river food web.

3. Students will conduct chemical and physical investigations of aquatic environments.

4. Students will suggest ways that river quality can be improved and explore avenues through which they can take action.

5. Students will network with other schools that are part of their the Water Watch Global Community. Networking activities will include sending other schools data on the quality of their water test site, analyzing other schools' water test site, and engaging in collaborative projects.

Planning Chart: Project Water Watch

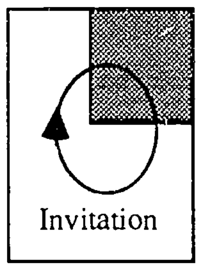
Activity	Title	Telecommunications Alert	Time Period
1	Where Does Your River Come From, Where Does It Go?	Yes	1 session
2	Field Trip#1: Observing the Physical and Chemical Characteristics of the River	No	1 session
3	Making Sense of the River Data	Yes	1-2 sessions
4	Field Trip #2: Collecting and Identifying Aquatic Macroinverte-brates	No	1-2 sessions
5	Using Macroinverte-brates as Bioindicators	Yes	1 session
6	Protecting Our River	Yes	1 - 3 sessions

Where Does Your River Come From, Where Does It Go?

Testing a river is like taking the pulse of a continent. How healthy our waterways are can tell us much about the way we live. However, just as our body is very complex and is difficult to understand, so are our rivers. The following activities only scratch the surface of river ecology and one must be careful about drawing hasty conclusions.

The following activity is designed to allow students to identify the source of their water supply and, if possible, to trace this source back to its origin. By examining the source of their water supply, students will become aware of the physical link they have with other students living many miles away. In addition to the human connection, students will become aware of possible industrial or agricultural sources of pollution of their water supply.

Objectives



• Students will use maps to trace their local river, its tributaries, and it destination.

• Students will locate cities, factories, and other potential pollution sources on the map.

• Students will use the map to generate research questions and select study sites.

Materials

Maps showing local rivers, water ways, and their tributaries.
(One topographic map per class, one regional map per team).
Information on cities, factories, farms, and other potential pollution sites (e.g. newspapers, Chamber of Commerce information).
Highlighters (2 different colors per team)

Procedure

1. Open the activity by holding up a glass of water and asking the students, "Where did this come from?" Encourage them to trace the water back from the tap to the actual supply source.

2. Briefly explain to the students that there are a variety of water supply sources. See if they can name them (groundwater, rivers, and reservoirs).

Pass out a map of the region to each team. Have students locate their city/town, and the water supply. Then ask students to trace this supply source (or its tributaries) back to the origin. Students should use a highlighter to mark this route on their maps.

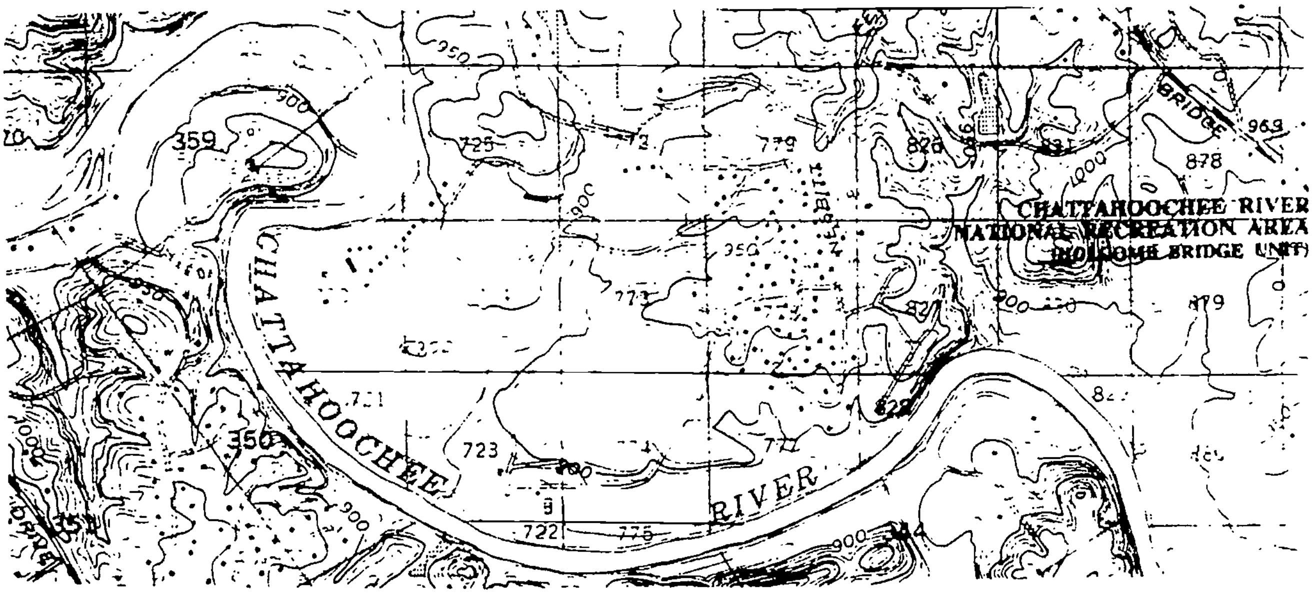


Figure 1. Topographic map showing the Chattahoochie River near Atlanta

3. Having traced their water supply back to its origin, have teams identify and list
   a. the major cities/towns upstream from their water supply source.
   b. industries or rural farmlands located on the water supply route. Students should attempt to find out what contaminants from these sources might find their way into the water supply.

4. Pour the glass of water down the drain. Ask the students to trace its journey downstream. (Teams should mark the route in a different color highlighter on their maps.)

5. Ask teams to discuss the following questions, and to be prepared to report on their discussion to the class:

   a. What is the value of knowing where your drinking water has been and where it is going?
   b. In terms of water purity, where would you find the purest and cleanest drinking water, at the origin or at the end of a water supply source? Why?
   c. What questions do you have about the quality of your local water supply, now that you know something about its source?

6. Ask cooperative groups of students to use their questions to suggest a study site and plan that may answer their questions.

7. Hold a class meeting to decide which question the class wants to try and answer. Practicality will be important. Easy and near access will be important. Consider also how many times a year you should study river? (When does nature change the "Quality of the river?"). Rivers should be monitored four times per year corresponding to each

season. If you can arrange to visit the same river during two different seasons, students will be able to compare river quality data for different seasons.

Optional Extensions

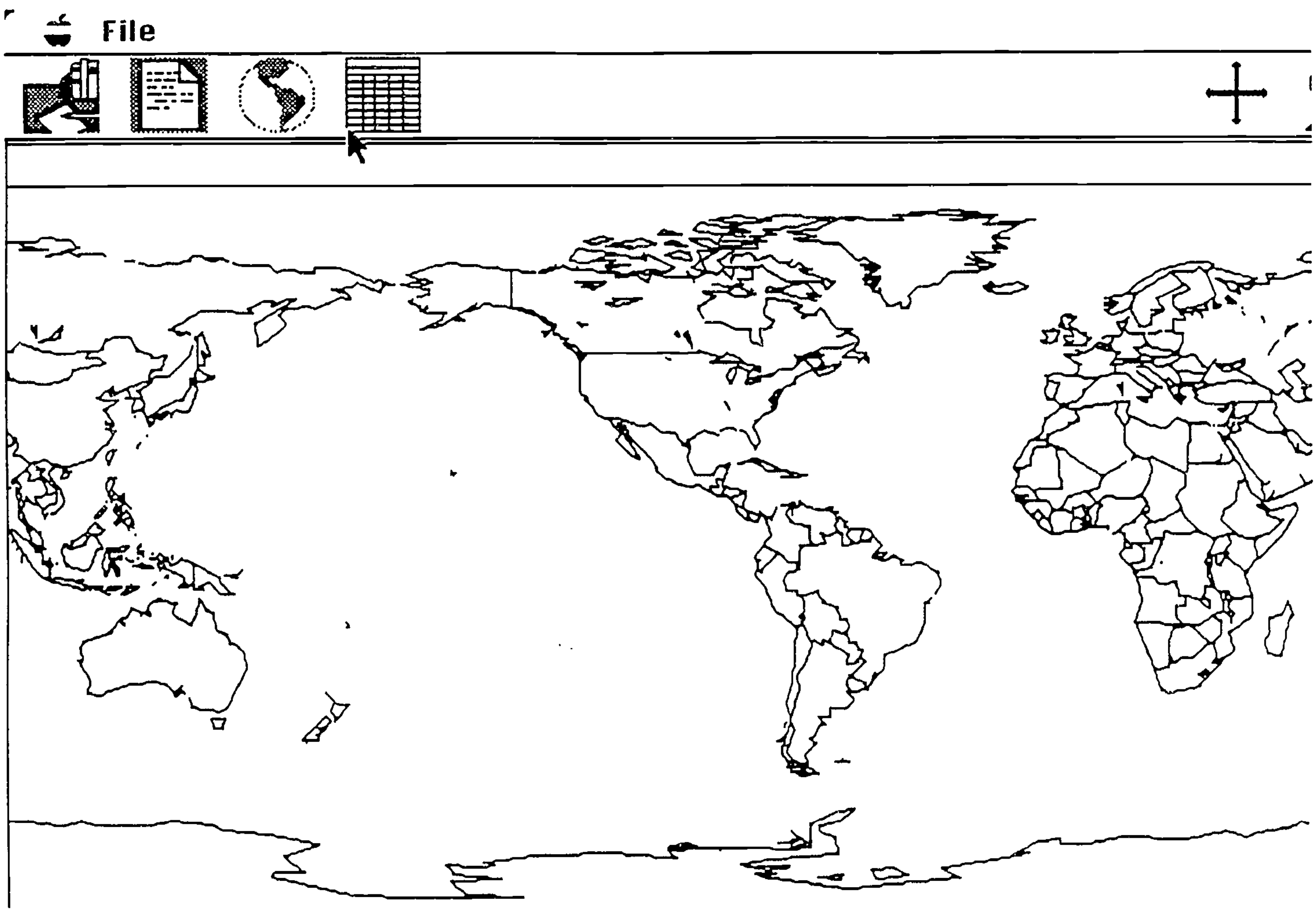
1. Conduct an investigation of the local water treatment plant, to understand how water is treated before it is allowed to be dispersed as drinking water.

2. Visit a sewage treatment plant, to learn how waste water is treated before it is released.

3. Contact students in other schools in the Water Watch Global Community utilizing the same supply source. Share information about each other's surroundings (industries, agriculture, etc.) that might affect the purity of the water supply. Discuss how these surroundings could affect the supply source.

4. Conduct a survey of other Water Watch Global Community schools to determine the most common source of drinking water. How many students obtain their drinking water from ground water (wells)? Rivers? Reservoirs?

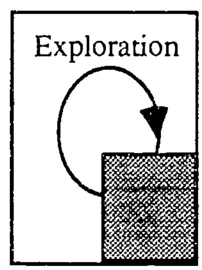
5. Make a large map of the world, and plot the locations of all the schools that have joined the Water Watch Global Community.



Field Trip #1: Observing the Physical and Chemical Characteristics of the River

The physical, biological and chemical qualities of a body of water such as a river are very complex and are constantly changing. To perform a "complete" analysis can be very expensive. In this activity students visit their river (or another body of water) and describe its quality using quantitative and qualitative methods, with an emphasis on using their senses. Students develop a quality profile of their river, and report their results to the Water Watch Global Community participants.

Objectives



- Students will visit the river or body of water chosen for study.
- Students will learn a variety of methods for investigating the river.
- Students will discuss the significance of their water test results.

Materials

Thermometers
Dissolved Oxygen Test Kit from CHEMetrics
pH paper
Stop watch
Meter stick
Rubber boots and gloves
Safety goggles
Collection devices (jars, pails to bring samples back to the classroom)
Pencils, crayons, pens
Camera, video tape machine (optional)

Advance Preparation

You will need to decide upon a body of water that your class will use as their test site. We recommend that you try and find a site very close to your school. It does not have to be a large body of water. For safety considerations, we recommend a small stream that is readily accessible to you and your class.

Visit the test site ahead of the time to determine the best way to access the stream, and whether it can adequately handle all students you plan to bring. Ideally, the site should allow all teams to conduct their studies in close proximity.

Safety Considerations

1. Do not take students to bodies of water that have the least bit of risk in terms of increased water flow.

2. If students are going into the water, bring rubber boots and gloves for those who will enter the water.

3. If your sample site is below (downstream from) a waste treatment site, or the waters are known to be polluted, make sure all students wear rubber gloves and wash their hands after exposure.

4. Students should be organized into pairs or small teams. NO ONE SHOULD BE OBSERVING OR COLLECTING ALONE.

Procedure

1. Organize your class into work groups, each of which will be responsible for observing and collecting data on the physical and chemical characteristics of the river. Each team should work as an independent unit, collecting data on the physical and chemical characteristics of the section of the river assigned to them. In the next activity, they will analyze their data by using tables and graphs to make sense of their observations. The data from each group will be compiled and the class will work together to synthesize findings about the site and send it over the Network to other Water Watch Global Community schools.

2. Before you go to the river, go over the observations and tests that each group will perform at the stream.

Dissolved Oxygen Test: This test is a measure of the oxygen in solution in water. Each group will make two measurements of dissolved oxygen using the CHEMetrics self-filling ampoules. The ampoules draws water into its chamber which mixes with an indicator which changes color. The oxygen level is determined using a colorimetric scale. Students will report dissolved oxygen in parts per million. Cold water fish require DO levels not less than 8 ppm during early stages; not less than 4 ppm for other life stages; warm water fish require DO levels not less than 5 ppm for early life stages; not less than 3 ppm for other life stages.

pH Test. pH is a measure of the hydrogen ion concentration in water. pH is measured on a scale from 0 (most acid) to 14 (most alkaline), with 7 considered "neutral." Each group should make two readings and average the results. The pH will be measured using a short range pH paper. Students need to be sure not to touch the end of the pH paper used to test the water. To protect fresh water fish life, pH range should be 6.5 - 9.0.

Water flow: Water flow is a measure of the velocity of water in a river. Water flow should be reported in meters/sec. To measure the flow, have students mark off a ten meter length along the river in their area. Use a cork (or a leaf) and watch, and determine the time in seconds that cork takes to flow ten meters. Report the velocity as m/sec. To compute the velocity, sample the flow 2 times and take the average.

Depth: Use a meter stick to determine the depth of the water in the site area. If it is safe to do so, have the students determine the depth at various points across the river. Students can use this information to draw a cross section of the stream.

Temperature: Students should measure the temperature from two samples and take the average. Report in degrees Celsius.

3. At the river, teams should make their observations and record them on the Water Watch Data Recording Form (Figure 2).

Optional Extensions

1. Students could bring in water samples for testing from bodies of water near their homes.

2. If more elaborate instruments and/or test kits are available, a more complete analysis could be performed.

3. A local water testing lab could be encouraged to become interested in your project. They could provide backup testing (to determine the accuracy of your methods) and possibly might conduct some sophisticated testing for you (maybe test for PCBs, pesticides, etc.)

Water Watch Observations
Global Thinking Project

Team Name:________________________Team Members:____________________

Measurement Site (circle one): river, creek, pond, lake, ocean, other:________________

Date:______________________________Latitude:__________________________

Weather:___________________________Longitude:_________________________

Quantitative Measurements

Air Temperature:__________

Water Temp.:__________#1 __________#2 __________Ave.

Depth: ________#1 ________#2 ________#3 __________Ave.

Flow:__________#1 __________#2 __________Ave.

D. Oxygen:__________#1 __________#2 __________Ave.

pH:__________#1 __________#2 __________Ave.

Qualitative Measurements (Circle one of words)

Land use	Wooded	meadow	park	residential	commercial
Erosion	none	gullies			
Ground cover	grasses	shrubs	trees	soil	
Odor	rotten egg	musky	oily	sewage	none
Algae color	n/a	light green	dark green	brown	blue
Bed bottom color	gray	orange/red	yellow	black	brown
Surface water	clear	oily	foamy	milky	muddy
Discharge	yes	no			

Notes:____

____

____

____

____

____

Figure 2
Water Watch Observations
Global Thinking Project

Sketch a segment of the river (or body of water). Include as many details as possible.

Draw a Cross Section of the body of water. Include as many details as possible including the location of plants and rocks.

Making Sense Out of the River Data

In this activity students will mathematically analyze their data by creating data tables and graphs using the ALICE Data Tool. Each group will contribute their data to the class, and the class will work together to synthesize the data. The class will share their results with other members of the Water Watch Global Community and post their results in the gtp.waterwatch conference.

Objectives

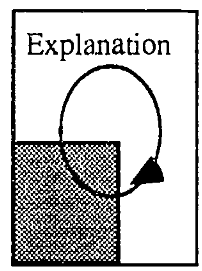
• Students will make a table organizing their quantitative and qualitative observations

• Students will synthesize findings about the site.

• Students will send a report to the Water Watch Global Community schools

• Students will organize the data into a master table (spreadsheet) obtained from other Water Watch Global Community schools

• Students will map data from the Water Watch Community using the ALICE Map Tool



Materials

Project Water Watch Observation forms with data
Paper
Pencils, rulers
Chart paper

Procedure

1. Each team should create a table including all of their quantitative and qualitative data. The table can be set up on paper, and then posted on a class data table. Each group should record its data on the class data table.

Row	Temp	Time	Date	Site	School.	Lat.	Long.	Depth	Flow	$D.O_2$	pH
1											
2											
3											
4											

Figure 3. Data Table showing quantitative water data

Row	Land use	Erosion	Ground cover	Odor	Algae color	Bed bottom color	Surface water	Discharge

Figure 4. Data table showing qualitative water data

2. Conduct a class discussion to synthesize the findings of the groups. A synthesized set of data (quantitative and qualitative) should be posted on the class data table. Some students should take responsibility for creating a master data table using the ALICE Data Tool.

3. Using the formats shown here, send a report of your class' water watch data to the Water Watch Global Community and the gtp.waterwatch conference.

Note: When you send a report to the other schools in the Water Watch Global Community, send it as a string of data rather than as a data table. When you receive data in this format, it will be easy to integrate it into a Water Watch Global Community Data Table.

Water Data: Quantitative

Format

<temp>, <time>, <date>, "<site>", "<school_name>", <latitude>. <longitude>, <depth>, <flow>, <Dissolved oxygen>, <pH>

Units

Temperature	^oC	degrees Celsius
Time	hh:mm	time at start, 24 hr format
Date	dd-mmm-yy	day-month-year
Location	"<site>"	creek. river. pond (lake). ocean
School name	"<school name>"	
Latitude	dd:mm	degrees, min, N or S

Longitude	dd:mm	degrees, min, E or W
Depth	cm or m	centimeters or meters
Flow	m/sec	meters per second
Dissolved oxygen	ppm	parts per million
pH	unit	1 - 14

Water Data: Qualitative

Format
<land use>, <erosion>, <ground cover>, <odor>, <algae color>, <bed bottom color>, <surface water>, <discharge>

Units

Land use	housing, office, recreation
Erosion	none, gullies, BWA
Ground cover	trees, shrubs, grasses, soil
Odor	rotten eggs, musky, oily, sewage, none
Algae color	n/a, light green, dark green, brown, blue-green
Bed bottom color	grey, orange-red, yellow, black, brown, green, other
Surface water	clear, oily, foamy, milky, muddy, brown, black, gray, other
Discharge	yes, no

A sample report send over the network might look like this:

To: Water Watch Global Community

From: Yaroslavl 22, Russia

Here are the results of our investigation of a small river near our school.

Quantitative Water Data:

12, 14:00, 2-Feb-94, river, Yaroslavl, 55:05 N, 30:25 E, 0.5, 0.2, 8, 5.5

Qualitative Water Data

wooded, none, shrubs, none, n/a, gray, clear, no.

We are anxious to receive your reports so that we can compare our results.
Yaroslavl water watchers,
Irina, Boris, Vadim, Olga

4. As data is received from other schools in the Water Watch Global Community, add it to the large class data table, as well as to the data table created using the ALICE Data Tool.

Row	Temp	Time	Date	Site	School	Lat.	Long.	Depth	Flow	$D.O_2$	pH
1	12	9:00	2-2	creek	Salem JH	32 N	84 W	0.5 m	0.4	8	5.5
2	2	10:00	1-29	river	Mos 91	55 N	35 E	0.4	0.8	7	6.5
3	10	14:00	1-30	river	Lavinia	41 N	2 E	0.1	0.2	7	5.5
4	16	13:00	2-5	creek	Oberon	38 S	144 E	0.5	0.5	8	5.5

Figure 5. Sample data from Water Watch Global Community. Data tables like this should be created on a large sheet of paper as well as using the ALICE Data Tool. Qualitative observations should be added to the table to make it complete.

Optional Extensions

1. Suggest to the class that different groups analyze the data received from other members of the Water Watch Global Community. Students can make graphs of some of the data to answer questions about the physical and chemical characteristics of the sites studied. Students use the graph to judge similarities and differences in the sites investigated.

2. Some students might like to use a large map of the world to post some of the interesting results obtained from other Water Watch Global Community schools. They can identify the locations of the sites, and some of the salient characteristics reported.

3. Have the class synthesize the data received from other Water Watch schools and write a brief report and sent it the Water Watch Global Community schools. If you do this, be on the look out for other schools' reports so that your students can respond to them.

4. Using the ALICE Map Tool as a reference, student might begin a study of the location of important rivers in each of the Global Thinking countries. Students can construct a bulletin board showing the major rivers.

Field Trip #2: Collecting and Identifying Aquatic Macroinvertebrates

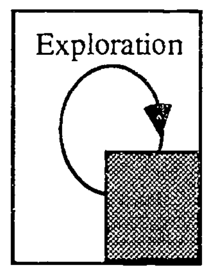
In this activity, students will collect and identify the macroinvertebrates present in the body of water they are studying. The counts obtained in this activity will be used in Activity 5 to estimate the degree of organic pollution present.

Objectives

- Students will collect, examine, and identify major groups of river macroinvertebrates.

- Students will research the organisms collected to find out their habits and what they eat.

- Students will construct a simple food web from their research which will serve as a simple model of their river ecosystem.



Materials

for each team:

white plastic dishpan
white soup bowls, compartmentalized Styrofoam plates or the light-colored plastic trays from some brands of microwave dinners
forceps
hand lenses
aquatic net (D-frame or triangular)
empty gallon milk jug (for filling with stream water)
vials with screw caps or stoppers for storing specimens
rubbing alcohol
vial rack (can be made by drilling appropriate-sized holes in a 2x4
labels
pencil
data sheet (Figure 6)
clip board

rubber boots
rubber gloves
identification key (Figure 7)

for class:

first aid kit
Field Guides, such as Lehmkuhl (1979) *How to Know Aquatic Insects* (Dubuque, IA: Wm. C. Brown).

Procedure

Note to the teacher: It is important to sample a variety of habitats in the process of collecting macroinvertebrates. Examples of habitats are leaf packs, submerged wood, plants, rocks, stream surface and stream bottom. You might want to assign each team a different habitat on which to concentrate. Another way to vary the sample is to assign a team to different locations along the stream, and have them sample as many habitats as possible. The goal is to collect the largest number and widest variety of samples possible, since the accuracy of the biotic index (see activity 5) depends on at least 100 organisms being processed.

Caution students to avoid direct contact with the river water, in case it is polluted.

Each team should follow the procedure outlined below. The class data can be pooled for Activity 5.

1. Record date, time, and site information, and a draw a quick sketch of the collection site.

2. Collect a sample by holding the collecting net in open, moving water while stirring up the stream bottom, rocks, and/or plants. Students can hand pick organisms of rocks and plants. If a surface sample is desired, skim the surface with the net.

3. Empty the net into a large white dishpan, and rinse with a small amount of stream water. As organisms emerge, carefully separate them into a small container (a bowl or small pan) which has a half inch or so of clear water in it.

At this point, organisms can be taken back to the classroom for identification (they will keep for about 24 hours if refrigerated), or identification can be made at the site.

4. Continue to repeat steps 2 and 3 until the class as a whole has gathered a representative sample of organisms from the site (at least 100 is desirable).

5. Sort the organisms into similar-looking groups, and identify as many as possible using the key in Figure 7 and field guides which may be available. Enter the number of each type of organism on your data table.

6. Transfer representative examples of organisms to vials containing isopropyl alcohol, to start a reference collection. Label the vials with the date and collection site, as well as the name of the organism. Change the alcohol after two days, and check monthly thereafter.

7. Have students research food webs and then attempt to construct their own river food webs. They should feel free to include organisms they did not collect, but know live in the river (e.g., fish, plants).

Optional Extensions

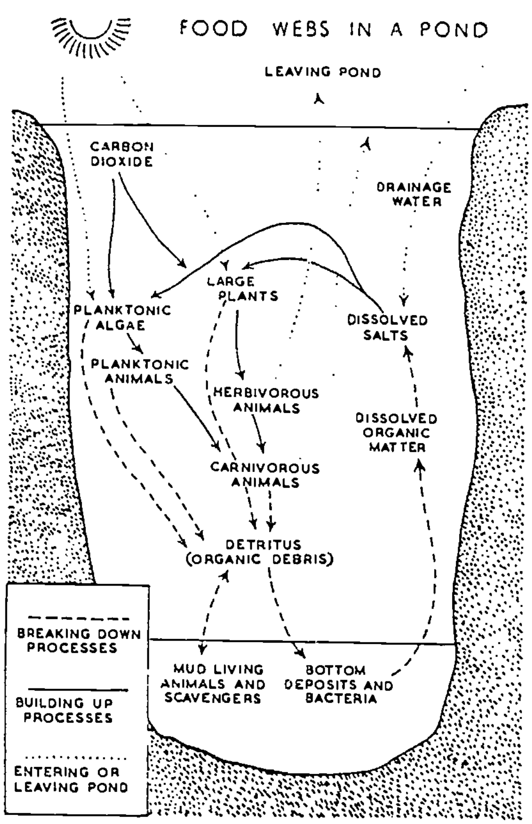
1. Students enjoy drawing detailed colored pictures of the organisms for display in their classroom.

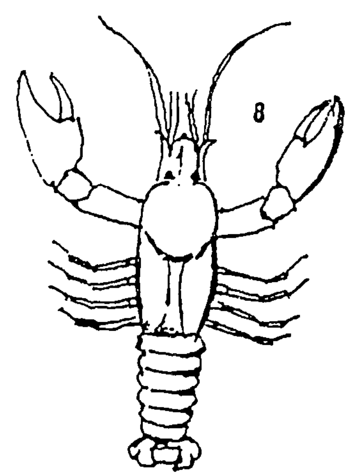
2. Have students research food webs and then attempt to construct their own river food web. Students should be encouraged to include both organisms they collected and organisms they know live in the river but were not collected, such as fish and plants.

3. Construct a bulletin board model of the river food web.

4. Prepare a dramatic presentation of the river food web.

5. Invite a fisheries biologist to give a talk on the fish and other life in the river.





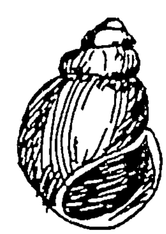


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Figure 6. Aquatic Macroinvertebrates Monitoring Survey
Global Thinking Project

Group:________________________ Group Members:____________________________

Location: river:________ creek: _______ pond:________ lake:________ ocean:_______

Date:_________________________ Weather_____________________________________

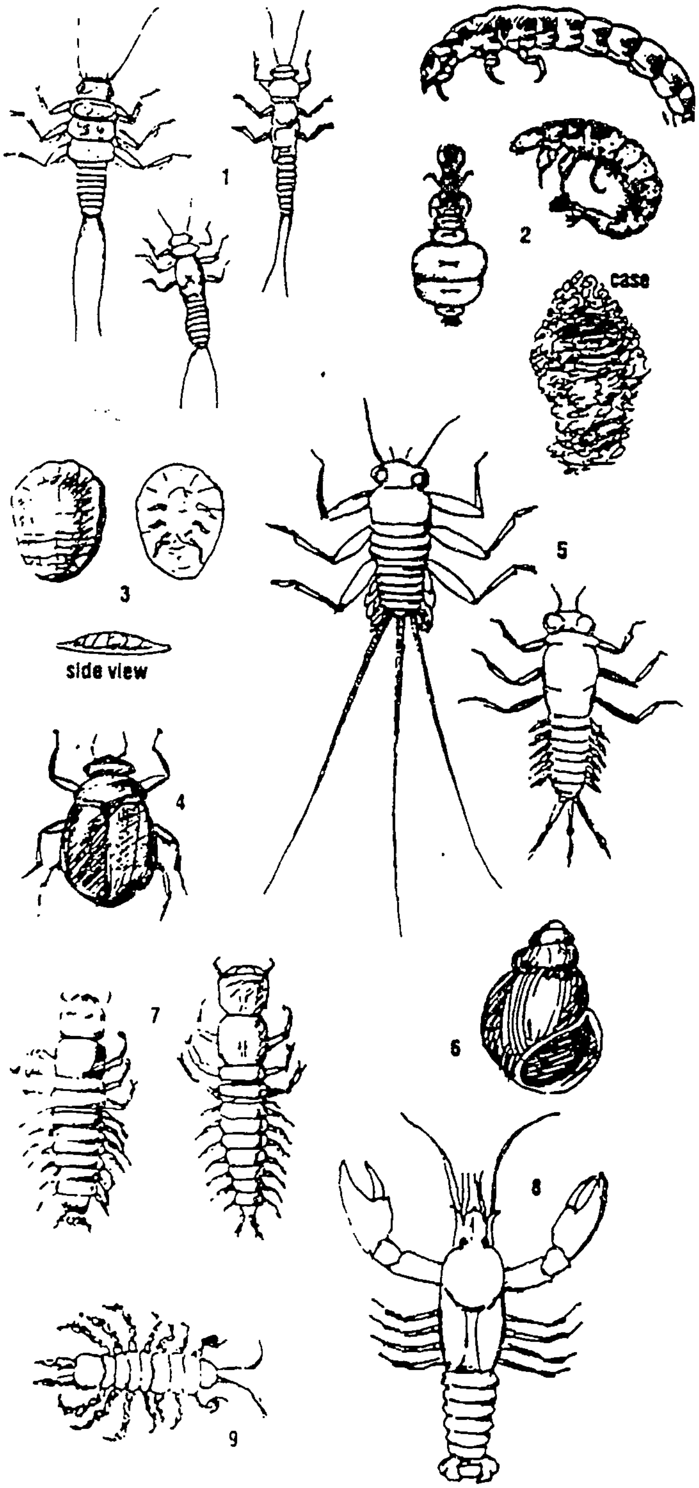
Air Temp:_____________________ Water Temp__________________________________

Depth of Water in Collection Site:_______________

Sketch of Collection Site:

Group One Taxa: Pollution sensitive organisms found in good quality water		Group Two Taxa: Somewhat pollution tolerant organisms can be in fair quality water		Group Three Taxa: Pollution tolerant organisms can be in poor quality water	
Organism	Count	Organism	Count	Organism	Count
Stonefly		Crayfish		Aquatic worm	
Addisfly		Sowbug		Midge fly larva	
Water Penny		Scud		Blackfly larva	
Riffle Beetle		Alderfly lava		Leech	
Mayfly		Fishfly larva		Pouch snail	
Gilled snail		Danselfly		Other snails	
Dobsonfly		Watersnipe fly lava			
		Crane fly			
		Beetle larva			
		Dragonfly			
		Clam			
Total sensitive		**Total Somewhat sensitive**		**Total pollution tolerant**	

Figure 7. Macroinvertebrates Identification Key[1]



GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

1 *Stonefly: Order Plecoptera* 1/2" - 1 1/2", 6 legs with hooked tips, long antennae, 2 hair-like tails. *Three examples.*

2 *Caddisfly: Order Trichoptera* Up to 1/2", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. *Four examples.*

3 *Water Penny: Oder Coleoptera* 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs on the other side. Immature beetle. *Three examples.*

4 *Riffle Beetle: Order Coleoptera* 1/4", oval body covered with tiny hairs, 6 legs, antennae.

5 *Mayfly: Order Ephemeroptera* 1/4" - 1", brown, moving, plate-like gills on sides of body, 6 large hooked legs, many long feelers on lower half of body, antennae, 2 or 3 long, hair-like tails. *Two examples.*

6 *Gilled Snail: Phylum Mollusca* Shell opens on right, opening covered by thin plate called operculum.

7 *Dobsonfly (Hellgrammite): Suborder Megaloptera* 3/4" - 4", dark-colored, 6 legs, many long feelers on lower half of body, short antennae, 4 hooks at back end. Contains fan-shaped gill tufts along sides. *Two examples.*

GROUP TWO TAXA

Somewhat pollution tolerant organisms can be in fair quality water.

8 *Crayfish: Order Crustacea* 1/2" - 6", 2 large claws, 8 legs, resembles small lobster.

9 *Sowbug: Order Crustacea* 1/4 - 3/4", gray oblong body wider than it is high, more than 6 legs, antennae.

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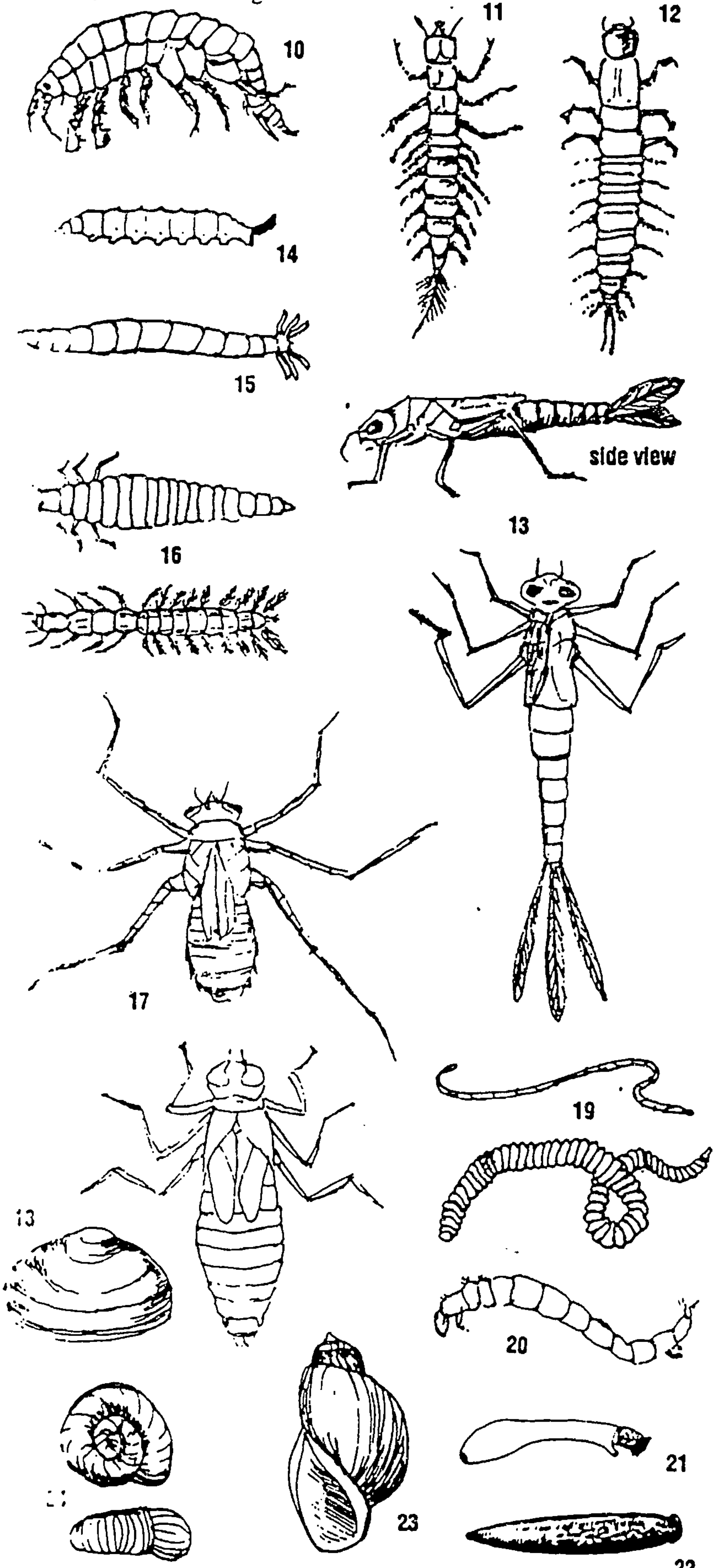
[1] From Save Our Streams, Isaak Walton League of America, 1401 Wilson Blvd., Level B, Arlington, VA 22209



GROUP TWO TAXA continued

10 *Scud: Order Crustacea* 1/4", fat body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11 *Alderfly larva: Suborder Megaloptera* 1" long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end.

12 *Fishfly larva: Suborder Megaloptera* 1" - 11/2" long. Looks like small hellgrammite but lighter reddish-tan color, often with yellowish streaks. Does not contain any gill tufts.

13 *Damselfly: Order Odonata* 1/2" - 1", large eyes, 6 thin hooked legs, 3 broad oar-shaped tails. *Two views*

14 *Watersnipe Fly Larva: Order Diptera (Atherix)* 1/4" - 3/4", green, tapered body, many caterpillar-like legs, conical head, feathery "horn" at back end.

15 *Crane Fly: Order Diptera* 1/3" - 2", green or brown, plump caterpillar-like segmented body, finger-like lobes at back end.

16 *Beetle Larva: Order Coleoptera* 1/4" - 1", light-colored, 6 legs on upper half of body, feelers, antennae. *Two examples*

17 *Dragonfly: Order Odonata* 1/2" - 2", large eyes, 6 hooked legs. *Two examples*

18 *Clam: Phylum Mollusca*

GROUP THREE TAXA

Pollution tolerant organisms can be in poor quality water.

19 *Aquatic Worm: Order Oligochaeta* 1/4" - 1", can be very tiny, thin worm-like body.

20 *Midge Fly Larva: Order Diptera* Up to 1/4", worm-like segmented body, 2 legs on each side.

21 *Blackfly Larva: Order Diptera* Up to 1/4", one end of body wider. Black head, suction pad on end.

22 *Leech: Order Hirudinea* 1/4" - 2", brown, slimy body, ends with suction pads.

23 *Pouch Snail: Phylm Mollusca* Shell opens on left. No operculum. Breathe air.

24 *Other snails*

Using Macroinvertebrates as Bioindicators

In addition to physical and chemical parameters, the diversity of plant and animal life present is another indicator of the relative health of a body of water. Decomposition of organic pollutants such as sewage, effluents from food processing plants and paper mills, and agricultural runoff results in consumption of dissolved oxygen from a stream or lake. As dissolved oxygen is depleted, macroinvertebrates and fish which have high dissolved oxygen requirement disappear, leaving behind a higher proportion of more pollution-tolerant species. Unpolluted bodies of water would have a greater diversity of species present, while polluted ones would have a less diverse population restricted to those species with relatively low dissolved oxygen requirements. Thus, the relative numbers of pollution-sensitive and pollution-tolerant macroinvertebrate species present in a body of water can be used as a biological indicator of organic pollution.

Methods of assessing species diversity range from very simple to very complex. A simple analytical procedure is suggested here, with a more complicated one presented as an optional extension. In all cases, it is important to remind students that factors other than organic pollution may affect species diversity, and that it is important to gather many samples from a site at different times of the year before drawing firm conclusions.

Explanation

Objectives

- Students will use the data collected to make preliminary conclusions about the health of the river ecosystem.
- Students will collaborate with other Water Watch Global Communities to compare the health of rivers.

Materials

data collected in Activity 4
copies of Tables 1 and 2

Procedure

1. Using the Data Tool in ALICE, create a table summarizing the number of organisms you collected that fall into the Group One, Two or Three taxa.

2. Create a graph to illustrate your results.

3. Send your data to other schools in the Water Watch Global Community. When you send a report to other schools, format the macroinvertebrate data in the following way:

Macroinvertebrate data format:

<date>, <location>, <weather>, <air temperature>, <water temperature>, <depth>, <number of group one taxa organisms>, <number of group of two taxa>, <number of group three taxa>, <latitutde>, <longitude>, <school name>, <town>

4. Using ALICE, create summary tables and graphs to illustrate the findings of the Water Watch Global Community. Write a brief analysis of these results and send it to members of the Water Watch Community and the gtp.waterwatch conference.

Optional Extensions

1. A simple mathematical method for calculating a biotic index is detailed in Lehmkuhl (1979). Briefly, taxa are assigned a numerical score between 0 and 5 that reflects their tolerance of pollution (the less tolerant, the lower the score). Using these pollution tolerance scores for individual organisms, it is possible to calculate a biotic index (BI) that is an indication of the water quality. The tables (1 and 2) below are included for students who are interested in identifying the taxonomic groups of the organisms collected and in calculating the BI. Students will need a good field guide for identifying aquatic insects. The formula for the BI is:

$$BI = \frac{\sum n_i a_i}{N}$$

where n_i is the number of specimens in a taxonomic group
a_i is the pollution tolerance score (see Table 1)
and N is the total number of organisms collected.

2. Identify members of functional feeding groups (shredders, collectors, scrapers, predators) and determine the percentage of each present in your sample. Compare with data from other sites. (for a simple key, see Cummins, K.W. and Wlizbach, M.A. 1985. Field Procedures for Analysis of Functional Feeding Groups of Stream Macroinvertebrates. Appalachian Environmental Laboratory Contribution No.1611, University of Maryland, Frostburg.)

Table 1: Biotic Index, scores for individual taxa (adapted from Hilsenfoff, 19977)

Taxonomic Group	Pollution tolerance Score
Plecoptera	
(Stoneflies)	
Capniidae, Leuctridae, Nemouridae	0
Taeniopterigidae	1
Chloroperlidae, Perlidae, Perlodidae	0
Pteronarcidae	1
Ephemeroptera	
(Mayflies)	
Baetidae	2.5
Baetiscidae	2
Caenidae	
Caenis	4
Brachycerus	2
Ephemerellidae	0.5
Ephemeridae	1.5
Heptageniidae	
Epeorus	0
Rhithrogena	0
Stenonema	2
Heptagenia	2
Leptophlebiidae	
Paraleptophlebia	1
Leptophlebia	3
Polymitarcidae (**Ephoron**)	1
Siphlonuridae	2
Tricorythidae	2
Odonata	
(Dragonflies and Damselflies)	
Agrionidae	0
Cordulegastridae	0
Aeshnidae	1
Gomphidae	0.5
Lestidae	3
Coenagrionidae	3
Trichoptera	
(Caddisflies)	
Brachycentridae	0.5
Helicopsychidae	1
Hydroptilidae	3
Molannidae	1
Philopotamidae	0
Rhyacophilidae	0
Hydropsychidae (**Cheumatopsyche**)	4
Polycentropodidae (**Neuroclipsis**)	4
Megaloptera	2
(Alderflies and Dobsonflies)	
Coleoptera	
(Beetles)	
Elmidae	2
Psephenidae	2
Diptera	
(True Flies)	
Blephariceridae	0
Ceratopogonidae (**Bezzia**)	3
*Chironomidae (**Chironomus**)	5
Empididae	4
Ephydridae	4
Rhagionidae	2
Tabanidae	2
Tipulidae	2
**Syrphidae	5

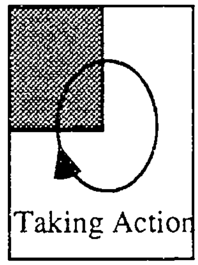
*Some members of this family have a score of 0.
**(Not from Hilsenhoff; added by DML)

Table 2: Water Quality (adapted from Hilsenhoff, 1977)

Biotic Index	Water Quality
under 1.75	Excellent, no disturbance
1.75-2.25	Good, possibly some disturbance or organic enrichment
2.25-3	Fair, probably some disturbance
3.0-3.75	Poor, significant disturbance
over 3.75	Very poor, gross disturbance

Protecting Our River

Understanding the ecology of the river through data collection and analysis is an important step in protection of this resource. However, what can we do to make sure this happens? In this activity we will research what avenues are open to an informed public.



Objectives

• Students will research water quality laws that pertain to their river.

• Students will learn what enforcement exists for river protection.

• Students will become aware of public and private organizations concerned with water quality and river protection.

• Students will brainstorm actions that citizens can take to protect and improve their waterways.

• Students will take action to educate the public about the river ecosystem.

Materials

Phone books, newspapers and books on environmental organizations
paper, pencil, envelopes and stamps.
poster paper and art materials.

**Remember to check conferences on IGC, the weekly News Of Note, and the monthly IGC newsletter for resources and information on water quality. Refer to page 23 of Project Ozone for the procedure to search conferences on the IGC Networks.

Procedure

1. In cooperative groups, students should brainstorm ideas on what laws there are to protect the river. They should also discuss what happens when someone breaks one of these laws. If students have no idea, perhaps they could discuss what kind of laws should exist.

2. Contact should be made with government agencies charged with protecting water quality to find out what laws and enforcement exist.

3. Cooperative groups should discuss whether these laws are effective and what changes or additions seem needed.

4. Cooperative groups should investigate ways citizens can act to improve river water quality (lobbying legislatures to change laws, demonstrating, forming citizen groups, cleanup actions, using the media, public education, lawsuits, talking to business leaders, etc.). What organizations are there working in these directions?

5. Cooperative groups should decide on some action they could take to educate the public about their river. Educational posters and/or pamphlets on river quality and citizen action would be a good choice.

Optional Extensions

1. Students could invite representatives of public and private(and businesses along river) organizations to talk to the group on river protection and ecology.

2. Conduct further studies in other locations and at other times of the year.

3. Develop presentations (slides, dramatic presentation of river food web from Activity 2, etc.) to give at elementary schools and other organizations.

4. Match up students with elementary students for a river awareness field trip.

Global Thinking Notes

Project Ozone

I have been in love with the sky since birth. And when I could fly, I wanted to go higher, to enter space and become a "man of the heights.' During the eight days I spent in space, I realized that mankind needs height primarily to better know our long-suffering Earth, to see what cannot be seen close up. Not just to love her beauty, but also to ensure that we do not bring even the slightest harm to the natural world.

Pham Tuan
Vietnam

Ngay từ thời thơ ấu tôi đã yêu bầu trời. Khi được bay, tôi đã muốn bay cao hơn nữa vào khoảng không gian bao la để trở thành "con người ở tầm cao". Sau 8 ngày bay trong vũ trụ tôi thấu hiểu được rằng, tầm cao cần thiết cho con người trước tiên là hiểu rõ hơn Trái Đất đã chịu nhiều đau khổ, quan sát tất cả những gì mà ở gần ta không thể nhận thấy. Không chỉ để chiêm ngưỡng vẻ đẹp kiều diễm của Trái Đất, mà còn để nhận rõ trách nhiệm, cần phải tiến hành công việc thế nào cho tốt hơn để không làm mảy may tổn hại tới thiên nhiên.

Phạm Tuân

During the Summer of 1992, more than 200 scientist descended on Atlanta to study how smog (ozone) forms. As the newspaper article points out (see page 5), most people try to avoid dirty air, but for these researchers conducting studies of urban smog, the best environment is dirty air!

In an other newspaper's editorial column (page 5), an article began with this statement: "the world must move faster to stop making chemicals that destroy the Earth's protective ozone shield.

Ozone (O_3) is a gas that is found concentrated in the upper atmosphere, and in urban areas, especially on hot days. It is a highly reactive gas with a pungent smell. It can cause serious damage to plants, and can adversely affect the human respiratory system. High concentrations of ozone pose a serious health threat not only to people with respiratory disorders, but children and adults, especially if engaged in vigorous activity.

On the other hand, ozone absorbs ultraviolet light. The ozone layer in the upper atmosphere acts as a planetary shield preventing most the sun's ultraviolet radiation from reaching the earth's surface. For humans, most skin cancers are associated with exposure to ultraviolet radiation. There is evidence that the protective ozone layer above the earth is deteriorating, and that in some regions, an "ozone hole" has been detected.

Goals of Project Ozone

1. Students will become explore air pollution by investigating the nature of ozone, how it is formed in the troposphere and the stratosphere.

2. Students will design studies to explore tropospheric ozone in their cities and towns, and then use these results to collaborate with schools in the Ozone Global Community.

3. Students will use a variety of methods to monitor tropospheric ozone.

4. Students will discuss the implications of the deterioration of the protective ozone shield, and what should be done to resolve the problem.

5. Students will network with other schools that are part of the Ozone Global Community. Networking activities will include sending other schools data on the levels of ozone in their own towns and cities, analyzing other schools' ozone data, and engaging in collaborative.

In this project, students will investigate ozone by exploring the nature of ozone, how it is formed, and how it is being deteriorated, as well collaborate with students in other sites to share local data about ozone, and collaborate on a global study of ozone.

Note: If you implement Project Ozone in your class, you will become a member of the GTP Ozone Group. You should create a new "group mail list" in your Alice Network software address book. You will be sent the schools participating in the Ozone Group by the Global Thinking Project Headquarters. You will probably have some schools new to your students, and if that is the case, you might want to send them a Global Thinking Portfolio as you did in Project Hello.

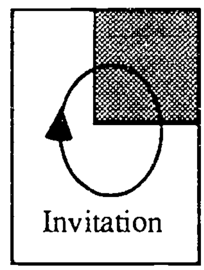
Planning Chart: Project Ozone

Activity	Title	Telecommunications Alert	Time Period
1	Ozone: The Good and the Bad	Yes	1 session
2	Ozone in Your Community	Yes	2 sessions
3	Ozone: A Global Study	Yes	2 sessions
4	The Changing Ozone Layer	Yes	1-2 sessions
5	Ozone: What You Can Do About It	Yes	2-3 sessions

Ozone: The Good and the Bad

After having students explore what they know about ozone, they will learn to differentiate between tropospheric ozone (the bad ozone), and stratospheric ozone (the good ozone).

Objectives
• Students will discuss their prior knowledge of ozone
• Students will generate questions about ozone
• Students will explain what is the difference between tropospheric and stratospheric ozone



Materials
Newspaper and science magazine articles, and sections from science texts about ozone, chart of the atmosphere

Advance Preparation
Well in advance of doing this project with your class, you should start collecting newspaper and magazine articles on ozone. You should collect articles that focus on any of the these topics: ozone, ozone hole, smog.

Procedures

1. Divide your students into teams of four, and give each team a large sheet of paper, and colored pens or crayons. Have the students draw a picture showing the earth and two of the layers in the atmosphere, as well a satellite in space, and the sun in the background (Figure 1). Then say to the students :

In the next ten minutes I want you to work as a team, and discuss what you know about ozone. Use the picture to draw and explain what your team knows. In your drawing and explanations, please try to use the following ideas as well as others that you know: ozone, smog, car emissions, ultraviolet light, people, plants.

Walk around the room and assist the students if they need help. At the end of the ten minutes, tell the students that you are going to randomly call on one person from each group to show their drawing to the class, and brief explain it. Give the students another two minutes to put their heads together to make sure everyone in their group can explain the picture if called on to do so. Randomly call a number (draw a card from a set with the numbers 1 through 4), and ask the person with that number to stand and explain their team's drawing. Remember, that this activity will give you insight into what the students know about ozone. There will be a range of knowledge in your class. When you have finished hearing the reports, ask a member from each team to mount the pictures on the wall in the classroom. Keep these pictures visible throughout the project, and refer to them when it seems appropriate.

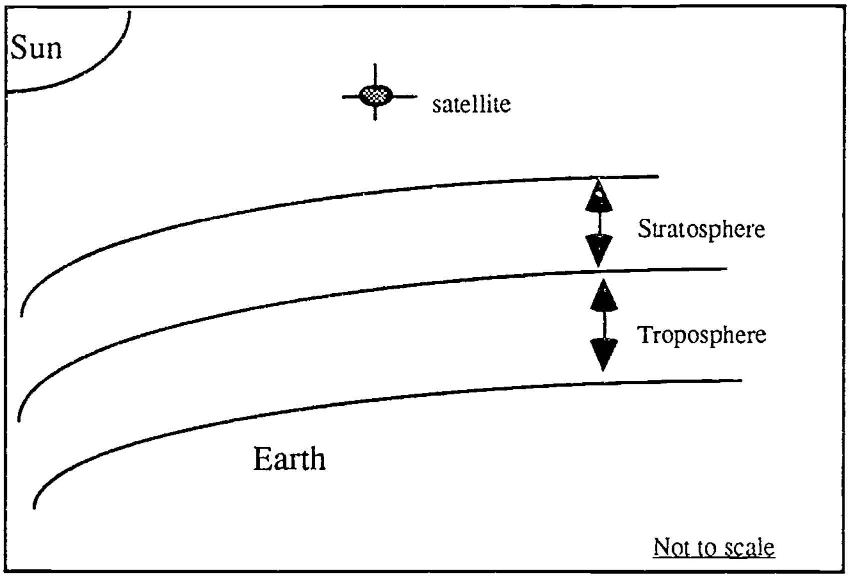


Figure 1. Picture to be used to help students explain what they know about ozone.

2. To help students identify different problems associated with "good" (stratospheric) and "bad) tropospheric ozone, provide each team with a "think piece" (an article from the newspaper, magazine or section of a text book). The "think piece" should be no more than two pages long, and should be used to get the students to think and reflect upon the topic under consideration: ozone. You can use the two "think pieces" that are included here, or you can use the articles that you have collected from the local newspaper and science magazines. Another good source for "think pieces" are textbooks. In any case, you should give each group two "think pieces," so that stratospheric and tropospheric ozone are discussed.

3. Students should be in groups of four. Pair the students off within the group. Then follow these procedures:

a. Give each pair a "think piece."
b. Have one student in each pair read the "think piece" to his/her partner.
c. Each pair should work by themselves and analyze the article. Students might make a drawing or write a brief summary.
d. Each pair should then present their summary to the other pair.
e. The group of four should make a T-Chart summarizing the differences between "good" and "bad" ozone.
f. The T-Charts should be posted in a prominent place in the classroom

4. Summarize the work the students did on the "think pieces," by discussing the following concepts:

- Tropospheric ozone is produced when the gases given off from burning fossil fuels combine with sunlight. The result is ozone or smog.
- More data is needed about the sources, patterns and effects of tropospheric ozone.
- Lower atmospheric ozone is found in high concentration in many of the urban centers of the earth.
- Stratospheric ozone is formed when ultraviolet radiation brings about the dissociation of O_2. The free oxygen then combines with another molecule of oxygen to form O_3.
- Over millennia, the concentration of ozone has increased in the stratosphere enough so that a protective shield has been created that screens out almost all of the ultraviolet radiation reaching the earth.
- Presently there is a concern that certain chemicals (chlorofluorocarbons--CFCs) released into the atmosphere in recent years are reactive in stratosphere by breaking down in the presence of ultraviolet radiation. The free chlorine atoms that are released attack ozone molecules breaking them into oxygen and chlorine oxide. This process is responsible for the depletion of the ozone layer, and has resulted in the presence of a hole in the ozone layer over the Antarctic during Spring.
- The depletion of the ozone layer could result an increase of ultraviolet radiation reaching the earth's surface, which would cause damage in nearly all forms of life.

Optional Extensions

1. Have your students keep a "scientific log or journal" of their work on Project Ozone. Students can collect articles about ozone, newspaper clippings, as well as keep track of their work on the Project.

2. Students might want to produce a "newsletter" on ozone. Newsletters typically are very short---perhaps two pages, and summarize interesting ideas about a particular topic. Some of the students might want to create an Ozone Newsletter that could be shared with other students in the school, as well as over the network.

Think Piece 1
Stop Making Chemicals That Destroy the Ozone Shield

According to some scientists, global air pollutants are threatening to destroy the Earth's protective shield against the harsh ultraviolet rays of the sun. This shield, located in the thin upper reaches of the atmosphere (know as the stratosphere), consists of ozone.

The chief culprit threatening the ozone layer is a family of industrial compounds known as chlorofluorocarbons (CFCs). These chemicals include coolants used in air conditioners and refrigerators, as well as chemicals used in hair sprays and dry cleaning fluids. The CFCs released to the atmosphere eventually reach the stratosphere, where they react with ultraviolet photons. The UV photons break the CFCs down releasing a free chlorine atom which then attacks ozone molecules. According to some scientists this reaction is devastating to the ozone layer.

The sudden discovery of the ozone "hole" over Antarctica in 1985, showed that the concern was real. Studies showed that the concentration of "ozone" in a column over the South Pole had decreased by 40%, and that similar "holes" had been detected since then.

In 1987, over 40 nations met in Montreal, Canada, and adopted an agreement limiting the release of CFCs into the atmosphere. The Montreal Accord called for a 50% cut in CFCs by the year 2000. Soon after the Accord was reached, evidence showed that the ozone shield was being destroyed even faster than predicted. So, in 1990, a revision to the Montreal Accord was written calling for the banning CFCs by the year 2000. Recently, agreement has been reached to ban CFCs by as early as 1995.

Think Piece 2
Researchers Study City Smog

In the Summer of 1992, over 200 researchers descended upon the city of Atlanta to study how smog forms. As one of the chief researchers said, "To study ozone, you've got to have ozone. And ozone they had. The days that they were in Atlanta were hot and muggy, just the right conditions for the formation of ozone.

According to scientists, ozone forms at ground level when hydrocarbons and nitrogen oxides from factories, automobiles and trees react in the presence of sunlight on hot, sunny days when the air is stagnant.

Ozone formed in one location may be blown by the wind miles away to another location and cause serious health problems there. Ozone flowing from cities may cause enormous damage to crops and forests in rural areas.

The scientists in the Atlanta study were there to learn how ozone forms, and how ozone from Atlanta impacts the surrounding areas.

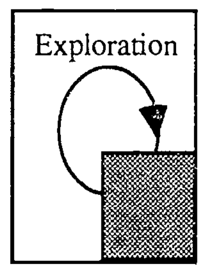
According to one report, the researchers were bombarding Atlanta's skies with laser beams, high-altitude balloons and helicopters. Air samples were being collected at 14 locations in the city on a 24 hour basis for the eight-week study.

Ozone is a growing problem, not only to urban areas, but to rural areas where winds carry polluted urban smog. In the Atlanta study monitoring sites have been placed "upwind" to see what air is like before it reaches Atlanta, and "downwind" to measure the air that flows out of the city. They want to know what is the effect of the city's dirty air on surrounding areas. Another monitoring site is in the Fernbank Forest, a preserved area in the middle of the city. Measurements were made of the hydrocarbons being released from trees.

More information is needed on ground level ozone, and you like these researchers, can begin to study the ozone patterns in your community and share your results with others.

Ozone in Your Community

In this activity study, your students will explore ozone in their community by using an ozone test strip monitoring system (Eco™Filter), as well as investigate some other methods of detecting ozone (the deterioration of rubber, and effect on plant leaves). Students will set up monitoring sites in order to make inferences about ozone in their community. They will use telecommunications to contact other students in their local area in order to increase their knowledge of ozone in their region.



Objectives

- Students will establish ozone monitoring sites in the local community
- Students will conduct experiments to determine levels and patterns of ozone
- Students will collaborate with other students locally using telecommunications
- Students will analyze the data and present it in graphical and map form
- Students will communicate their results over the Global Thinking network

Materials

Ozone test strips, colormetric chart, Ozone Monitoring Cards, thermometers, psychrometers, plastic tape, acetate sheets, clock, map of the city and surrounding towns, small plastic bags. Note: Ozone test strips and colormetric chart can be ordered from: Vistanomics, Inc., 230 North Maryland Avenue, Suite 310, Glendale, CA 91206.

Procedure

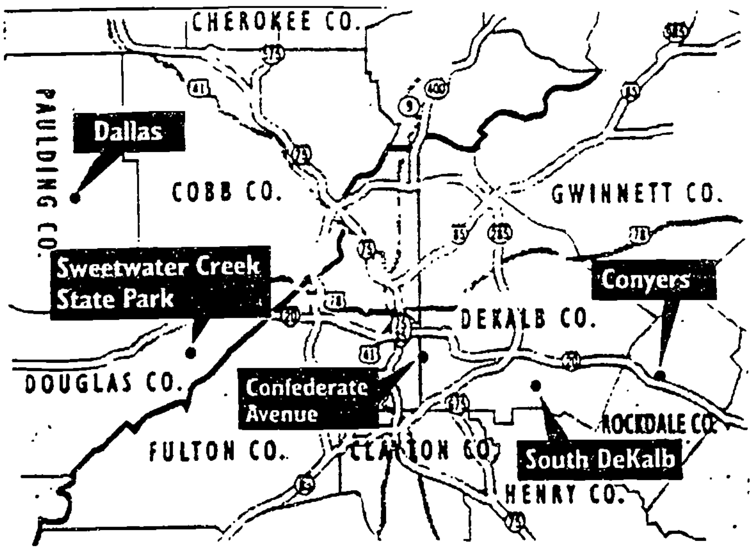
1. Show your students a map of your region, and explain to them that they are going to study ozone in the local community. To do this, they are going to set up some monitoring sites (student's homes would be suitable sites), and then collect data on ozone levels for a short period of time. The purpose is to study the ozone concentration levels and correlate these with local weather conditions, especially temperature, wind direction, and sunlight. You might share the map which identifies the location of Atlanta's ozone stations monitored by the State's Department of Natural Resources (Air Quality Section).[1] Explain to the students that their work will contribute to an understanding of ozone in the local community, and at the same time help them understand the cause of ozone, and it patterns of concentration.

---

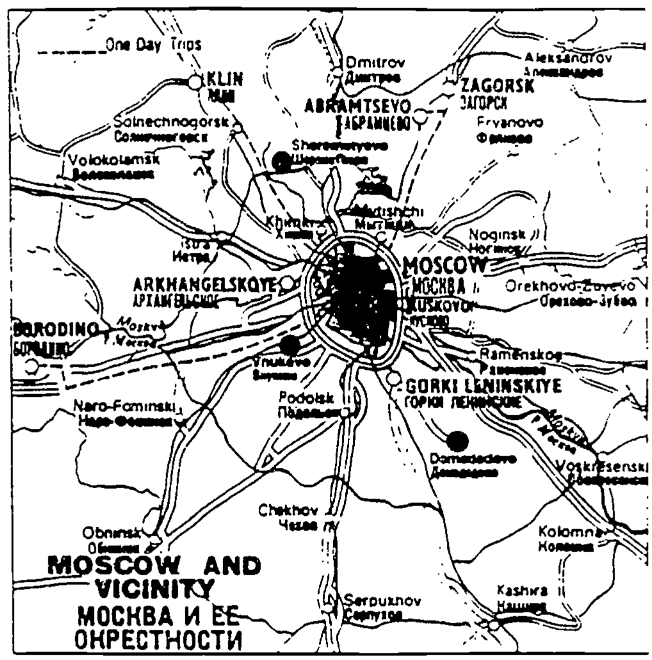
[1] Teachers in Georgia can call the Air Quality Section, of the Department of Natural Resources (404/656-5936) and ask for the ozone reading for the previous day. The figure you receive will be ozone in parts per billion. The reading is from the South Dekalb site (see the map).

2. Divide the students into four-member research teams. Each team should be responsible for at least one ozone monitoring site. Suggest that since the students live varying distances from school, using their homes as sites will expand the region that the class can monitor. One of the sites should be the school. Once each team has agreed upon a site, then the site should be identified on a map of the community. A good highway map of area will do. However, if you can, try and get a topographic map of your community. Place the map on a wall, and use markers to identify the location of the sites. Tell the students that they will participate in a global study of ozone by collecting data locally and then making the data available to other schools in the network (Activity 3).

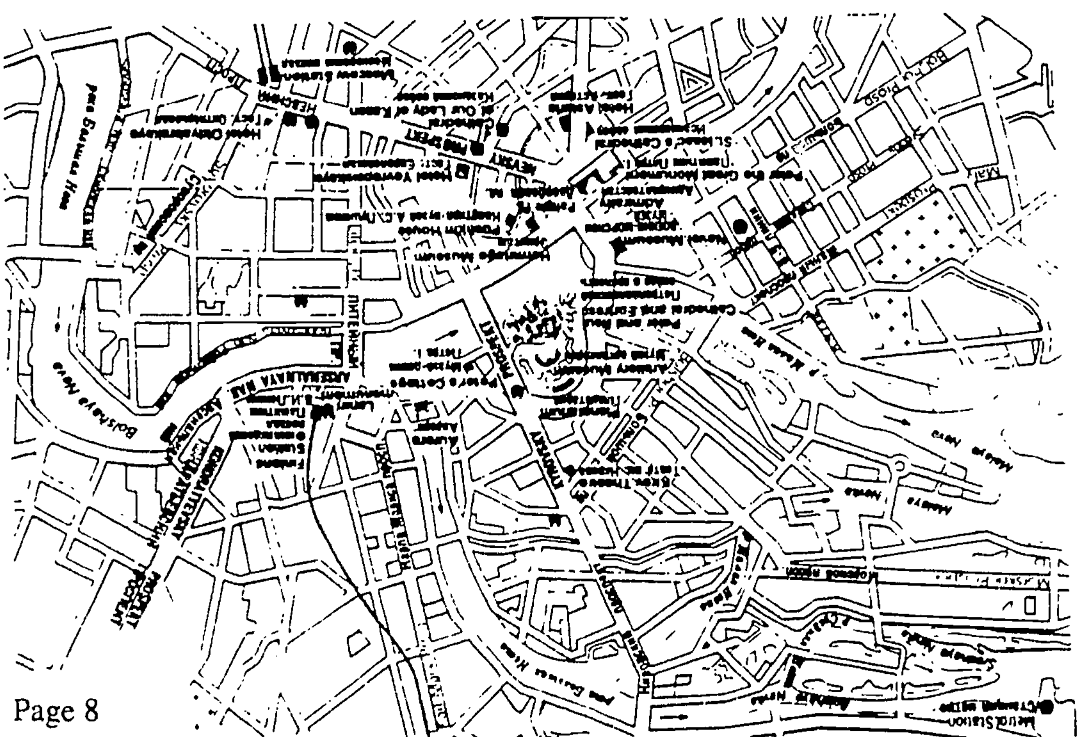
Ozone Monitoring Stations in Atlanta



Map of Moscow



Map of St. Petersburg



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3. Discuss with students how the ozone test strips work. (Refer to the documentation that accompanies the Eco™Filter kits).

4. The students can perform several tests at each site.

- Test 1: Measure ozone levels over four or five one hour intervals through the the day. To do this, they will need four or five one-hour test strips.

- Test 2: Measure the ozone over an eight hour period using an eight hour test strip.

- Test 3: Measure ozone levels over several days using eight hour ozone test strips.

Note: If you use the eight hour test circle, but don't leave it exposed for the full eight hours, you can use a time weighted formula to calculate the ozone level. The formula is

8 hours/number of hours exposed X reading on scale = time weighted ozone level

Students should use the Ozone Monitoring Cards (Figure 2)when they monitor ozone. The ozone test strips should be taped to them, and used as a way of organizing their data.

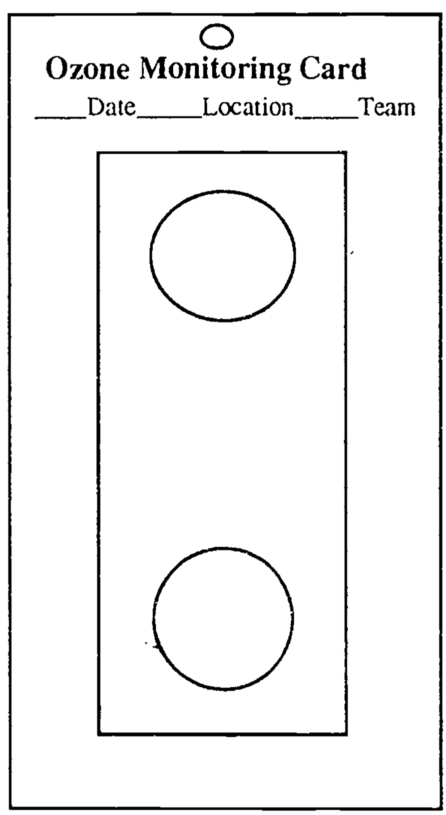

Figure 2. Ozone Monitoring Card

5. Each team should be responsible for conducting experiments over a one week period. This will enable them to study ozone for an extended time, as well as get daily ozone readings. Try and access other sources of ozone data (such as in Atlanta by calling the Department of Natural Resources). This data will helpful in testing the reliability of the test strips.

6. Work with your class to set up the experiments they will conduct. In each case, have the students formulate hypotheses that they will test through their experiments. For example, if the students do an experiment in which they measure ozone throughout the day, an hypothesis for this experiment:

> H: There will be differences in.the ozone levels measured in the shade at one hour intervals

Students should collect critical weather data including air temperature, humidity, wind direction, and light intensity. Additional hypotheses can be formulated with respect to these data.

7. Students should then write out brief proposals describing the studies they wish to conduct. The proposals should include a statement of the problem, one or more hypotheses, and a description of the methods they will follow in their study.

8. Students should begin monitoring ozone, as well as other weather variables. Students can create tables using the ALICE Data Tool (Figure 3):

Row	**Time**	**Ozone ppb**	**Temp. ^{o}C**	**Humidity**	**Wind Direction**	**Cloud Cover**
1						
2						
3						
4						

Figure 3. Student Data Table

9. Using the ALICE Data Tool, have students illustrate their data by making graphs. Data can be presented in a variety of forms. Figure 4 shows data collected from a site over a period of five days and presented on a single graph.

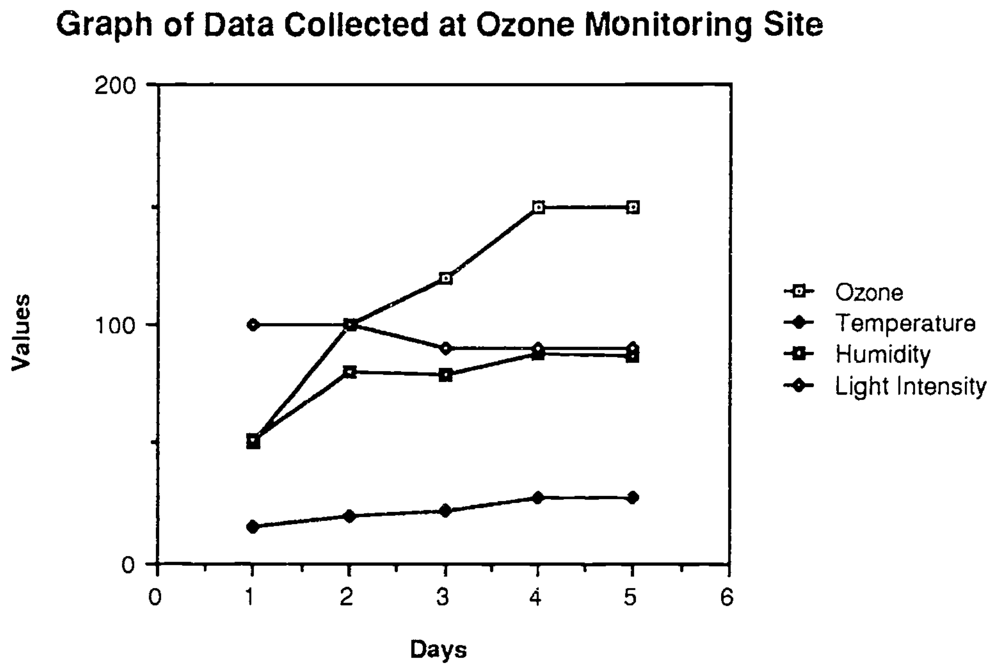

Figure 4. Ozone and Atmospheric Data Collected Over a Period of Five Days

Ozone should also be analyzed in terms of the number of days that exceeded the optimal level of ozone (120 ppb). Students should make bar graphs of the data as shown in Figure 5. Note that in this case, the optimal ozone level was exceeded on three days.

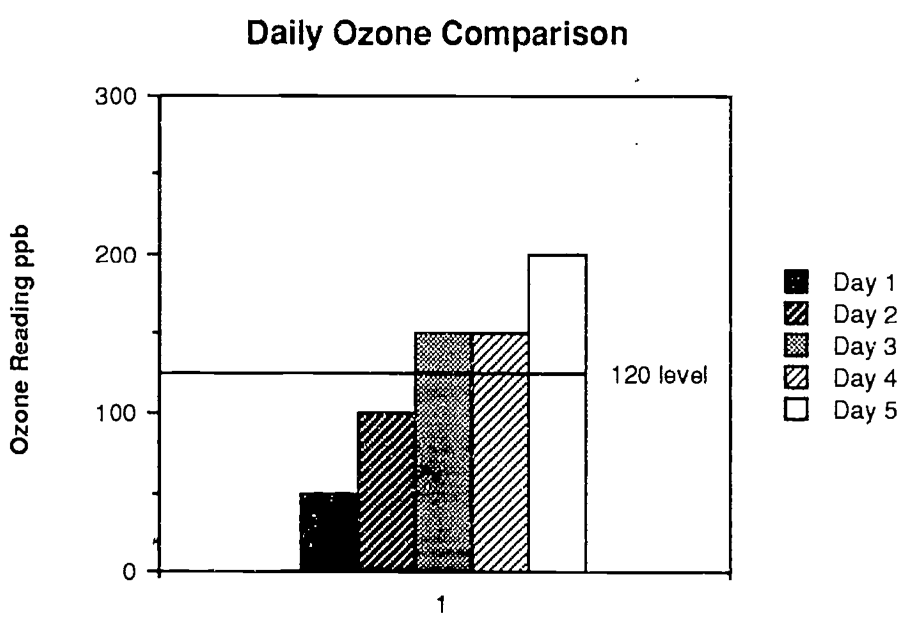

Figure 5. Ozone Readings

10. Have students propose explanations to the data they have collected and analyzed. They should attempt to look at the data collected from all the sites in their own class and try and make sense of the data. What is the pattern of ozone in their community? What is the level of ozone over the period they studied? What is the cause of the ozone? What can be done to reduce the level of ozone in their community?

Have each team study the data and formulate a set of explanations to their data. Conduct a session in which each team has an opportunity to present their data to the class. To maintain an atmosphere of interdependence within each group, and the class as a whole, tell the students that you will randomly call on a student from each group, and that the whole class will be responsible for making a general statement about ozone in their community based on the reports.

Air Quality	Good	Moderate	Unhealthful	1st Stage Alert	2nd Stage Alert
PPB on Eco™Filter	10 - 50	100 - 150	200 - 250	300 - 350	>350
Part per billion	<60	70-120	120-190	190-340	>340
Ozone Index reported to public. (ozone level/120 X100)	50	58 - 100	100 -158	158 - 280	>280

Figure 6. Ozone Conversion Table[2]

Optional Extensions

1. Students may want to take some action depending upon the results of their studies. They want to contact researchers in the area who are doing research on air pollution. They may want to report their findings to action groups in the community. And they may want to set up a display in the school that summarizes the results of their work.

2. Some students may want to go further in their research on ozone. Some of them may want to use an ozonometer, an instrument that measures ozone and is based on the fact that rubber breaks down in the presence of ozone. Contact Gaia and leave are message if you are interested. There is also a possibility that another test strip that detects NO_2 will be available soon. Since NO_2 is a primary pollutant, and precursor to the formation ozone, further research could be done correlating NO_2 and ozone formation. Check the gtp.teachers conference/

3. The growth of plants and changes in leaf damage can be used as a bioindicator of low level ozone. The Ozone Project developed by Watch, an environmental group in ENGLAND is an excellent resource you might want to consider ordering from Watch. The teaching guide contains seeds of plants which are sensitive to low level ozone, as well as instructions about planting, growing, and monitoring the plants to investigate low level ozone. Write to Watch, The Green, Witham Park, Lincoln, ENGLAND LN5 7JR Tel: (0522) 544400 Fax (0522) 511616

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[2]Based on *Let's Clear the Air About Air™ (High School)*. Glendale, California: Vistanomics, Inc., 1992, p. 20.

Figure 7
Project Ozone Observation Form

Team Name__________________________Team Members:________________________

Measurement Location: Inside:___________________Outside:__________________

Date:__________________________ Latitude:________________________

Start Time:______________________ Longitude:______________________

Quantitative Measurements

Ozone (EcoBadge Readings)

Location	Start Time	End Time	Reading 1 ppb	Reading 2 ppb	Reading 3 ppb	Average ppb

Temperature: ____________ ^{o}C

Relative Humidity: ____________%

Wind Speed ____________km/hr

Wind Direction ____________degrees

Precipitation ____________cm

Qualitative Observations: Circle one of the words to describe your observations:

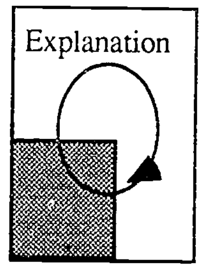
Ozone	Good	Moderate	Unhealthful	1st Stage Alert
Temperature	Hot	Warm	Cool	Cold
Humidity	High	Average	Low	
Clouds	Cloudy	Partly cloudy	No clouds	
Sunshine	Sunny	Mainly sunny	Mainly clouds	Cloudy
Wind Speed	Strong	Medium	Light	Zero
Wind Direction	North	East	West	South
Precipitation	Rain	Drizzle	Snow/sleet	None

PROJECT Ozone Activity 3

Ozone: A Global Study

Students will use telecommunications to contact students in the Ozone Global Community to discuss the problem of ozone, and share data in order to gain knowledge about ozone at the global level. Students will also discuss what can be done to alter the trend of increasing urban smog.

Objectives



- Student will collaborate with students in the Ozone Global Community to share data and collaborate on global ozone studies

- Students will discuss with students in other cultures the legislation that regulates air pollution standards

- Student will identify actions that need to be taken to curb ground level ozone

Materials

Data and conclusions from Activity 2, large map of the world, string, pins, labels or cards to post information on the map

Procedures

1. Discuss with the students the value of cooperating globally with other people to share data, draw conclusions, and make decisions about important problems, such as ground level ozone. Explain to students that they are going to collaborate with other students in the Global Thinking Project to find out about the problem of ozone in other countries, and at the same time share the results of their local ozone research.

2. Your class's ozone data from Activity 2 should be sent to all members of the Ozone Global Community and the gtp.ozone conference. If it hasn't been sent, take the time now to do so. The data should be sent over the Network in the form of report using the format shown below:

Ozone Data: Quantitative

<ozone>, <air temperature>, <wind speed>, <wind direction>, <precipitation>, <latitude>, <longitude>, (school name>, <town name>, <date>.

Explanations:

Ozone	parts per billion	Latitude	hh:mm N or S
Temperature	^{o}Celsius	Longitude	hh:mm E or W
Wind Speed	km/hour	School	name
Wind Direction	compass heading in degrees	Town	name
		Date	day-month-year
Precipitation	cm		

Sample Ozone Data:

```
Air quality data:

150, 28, 5, 165, 0, 34:00 N, 84:00 W, Rocky Mount, Marietta,
20-Oct-93
```

Ozone Data: Qualitative

<ozone>, <air temperature>, <humidity>, <cloud cover>, <sunshine>, <wind speed>, <wind direction>, <precipitation>

Explanations:

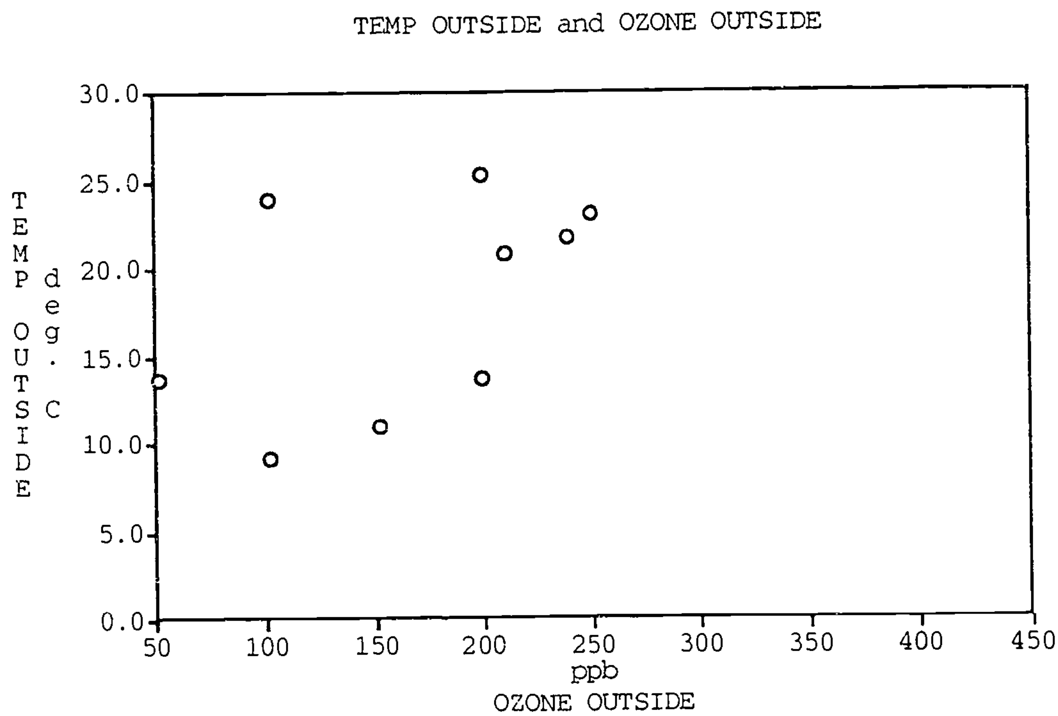
Ozone	Good, moderate, unhealthful, 1st stage alert	Sunshine	sunny, mainly sunny mainly clouds, cloudy
Temperature	hot, warm, cool, cold	Wind Speed	Strong, medium, light, zero
Humidity	high, average, low	Wind Direction	North, East, West, South
Clouds	cloudy, partly cloudy, no clouds	Precipitation	Rain, Drizzle, snow/sleet, none

Sample Qualitative Ozone Data

```
Air quality data:

    moderate, hot, high, no clouds, sunny, light, south,
none
```

3. As other schools send data, enter it into a class data table using ALICE. Use the Data Tool to make graphs to depict the data, and use the Map Tool to make maps of some of the data. Discuss the results with the class. A sample graph created with the ALICE Data Tool of ozone data plotted against temperature is shown below.



4. Have the students write brief analyses of the data using their graphs and maps to support their ideas. Have the students share the results in their own class, and send reports to the Ozone Global Community and gtp.ozone.

Optional Extensions

1. Encourage your class to make contact with one or more schools in the Ozone Global Community plan and carry out a collaborate study.

2. Some classes may want to collaborate with students who are researching lower atmospheric ozone as part of the Global Laboratory Project. Global Lab is a school-based, network science program developed by Technical Education Research Center (TERC) in Cambridge, Massachusetts. On the EcoNet system, type gl.bb.

3. Students may want to look into the laws that regulate the emission of gases that contribute to the formation of smog. For example, in the US, the EPA has established compliance laws regarding the ozone standards for US cities (see Figure 8). Students may want to inquire into the standards that regulate behavior in other countries.

V. Safety Procedures for Sample Collection

Collecting and analyzing water samples requires certain precautions and safety measures. Following are procedures to be followed by students and teachers collecting and analyzing water samples:

1) **If you are in doubt as to your ability to safely collect a sample, don't do it!** Be aware of your own physical limitations and the difficulty collecting water at certain locations under certain conditions.
2) High flows can turn even the most placid water into a raging torrent. Don't attempt to collect a sample if you feel the least bit of risk. **Avoid dangerous situations.** If there is an upstream dam that periodically releases water, the water level may rise swiftly. Please be aware of the timing of such releases and avoid getting caught in the middle of the stream during such an event.
3) Let someone know where you are going and when you expect to return.
4) Collect samples with a partner.
5) Some sample sites require wading. In any case, assume that you may get wet and wear appropriate clothing: footwear that can get wet (hip waders, old sneakers, "river runner" sandals, etc.) and will not slip on wet rocks, bathing suit or shorts. Bring a towel and a dry, warm change of clothes.
6) Bring a stick or pole along for balance climbing down steep banks or if you're wading.
7) Be careful when pulling off to the side of the road and leaving your car, so as not to endanger yourself or create a traffic hazard.
8) Consider leaving your wallet and keys in or around your car so they don't wind up downstream.
9) Watch out for poison ivy – it likes stream banks!
10) If sampling from a bridge, be wary of passing traffic! Don't lean over bridge rails while sampling unless you are firmly anchored to the ground or bridge structure with good hand and foot holds.
11) If sampling below a wastewater treatment plant, or in waters known to be polluted, wear rubber gloves and wash your hands after exposure.

VI. Safety Procedures for Lab Analysis

1) When conducting water quality tests that involves chemicals each group member should wear safety goggles as they would in a chemistry lab.

2) Make it a rule that those involved in sampling and in handling chemicals **must** wash their hands with soap and water afterward.

3) Have available a plastic container filled with water; this container should have a spout that can direct rinse water into someone's eye if needed.

4) Have available at the river rubber gloves for those who may have contact with the water. In particular, those students with open cuts on their hands should probably not handle river water until these cuts are covered and rubber gloves are worn.

5) Have available at the monitoring site a wash bucket in case of chemical exposure or undesired exposure to the river.

6) With each water quality test kit are Material Safety Data Sheets – **SAVE THESE!!** Keep them readily available in the lab. In the event of ingestion, exposure to the eyes, or to other parts of the body these sheets can offer you some direction on how to handle exposure.

[redacted]

To interpret the results of your benthic macroinvertebrate survey, please refer to the "Guide To Macroinvertebrate Sampling" published by River Watch Network which accompanies this guide.

To interpret the results of your chemical indicators, the U.S. Environmental Protection Agency and the Vermont Water Resources Board have determined minimum or maximum acceptable concentrations. These are called "water quality criteria" or "water quality standards." We compare the results for chemical indicators to these numbers.

A. **Dissolved Oxygen:**

1) **VT Water Quality Standard:**

Designated Cold Water Fish Habitat:

1) Salmonid spawning or nursery areas:
   * At all times: Not less than **7 mg/l or 75% saturation**
   * During late egg maturation and larval development, not less than **95% saturation**

2) All other cold water habitat:
   * Not less than **6 mg/l or 70% saturation**

Designated Warm Water Fish Habitat:
   * Not less than 5 mg/l or 60% saturation

2) **EPA Water Quality Criteria to Protect Fish Life:**

For Cold Water Fish (Early Life Stages) .... **not less than 8.0 mg/l**
For Cold Water Fish (Other Life Stages) .... **not less than 4.0 mg/l**
For Warm Water Fish (Early Life Stages) .... **not less than 5.0 mg/l**
For Warm Water Fish (Other Life Stages) .... **not less than 3.0 mg/l**

B. **pH:**

1) **VT Water Quality Standard:**
All Waters: **6.5 – 8.5**

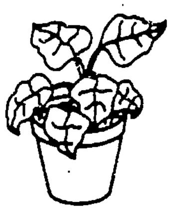
2) **EPA Water Quality Criteria**
To Protect Fresh Water Fish Life: **6.5 – 9.0**

C. **Total Alkalinity**

1) **Vermont Water Quality Standards**
To Protect Freshwater Aquatic Life: Not Less Than **20 mg/l as CaCO3.**

2) **EPA Water Classifications for Sensitivity To Acid:**

Acidified: Total Alkalinity less than or equal to 0 mg/l, pH less than 5.0
Critical: Total Alkalinity greater than 0 and up to to 2 mg/l
Endangered: Total Alkalinity greater than 2 mg/l and up to 5 mg/l
Highly Sensitive: Total Alkalinity greater than 5mg/l and up to 10 mg/l
Sensitive: Total Alkalinity greater than 10 mg/l and up to 20 mg/l
Not Sensitive: Total Alkalinity greater than 20 mg/l

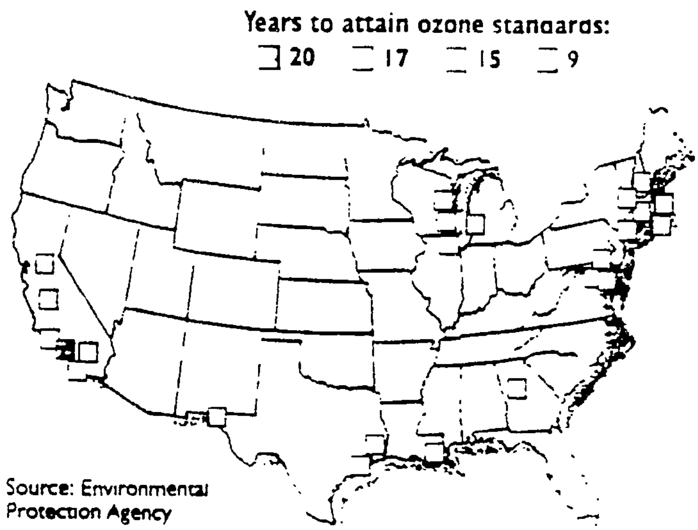


4. The growth of plants and changes in leaf damage can be used as a bioindicator of low level ozone. The Ozone Project developed by Watch, an environmental group in ENGLAND is an excellent resource you might want to consider ordering from Watch. The teaching guide contains seeds of plants which are sensitive to low level ozone, as well as instructions about planting, growing, and monitoring the plants to investigate low level ozone. Write to Watch, The Green, Witham Park, Lincoln, ENGLAND LN5 7JR Tel: (0522) 544400 Fax (0522) 511616

5. Have your class look at the data from the Ozone Global Community and pick out a school whose ozone data is very different than the data they collected. Have them formulate some questions to find out about their city in order to understand their ozone problem. Using the Network, contact the school and explore these differences and possible reasons.

6. Students should inquire into legislation that regulates pollution. For example, American schools should examine the EPA's Clean Air Act of 1990, and share essential parts of it with other. (Write to Gaia for help on this). Try and have the class collaborate with schools in other countries to discuss the laws regulating atmospheric pollutants.

Figure 8. Areas in the US that have between 9 and 20 years to meet EPA Ozone Standards.



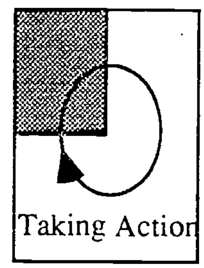
PROJECT Ozone — Activity 4

The Changing Ozone Layer

In this activity students will explore the nature of the ozone layer that protects the surface of the earth from ultraviolet radiation of the sun. They will find out how ozone is produced in the upper atmosphere, and what appears to be causing the deterioration of the earth's protective layer. Students will discuss the ways of curbing this trend, and in the extensions, explore a way to detect total column ozone levels.

Objectives

- Students will explain how ozone is destroyed by CFCs in the stratosphere.
- Students will identify was of curbing the deterioration of ozone.
- Students will discuss ways of detecting and measuring ozone (total column).



Materials

spray can, set of Styrofoam spheres to make molecular models (or a variety of colors of clay), light meter, UV detector

Procedure

1. Begin the lesson by showing a spray can product, and spraying a small amount into the air. Then say: "Some of the chemicals in spray cans can effect the ozone layer. How can this be?" Give students a few minutes in their groups to discuss what they know about this statement, and what might be creating the problem.

2. Explain to students that over millennia, that a layer (see Figure 9) of ozone (O_3) has been built up by the interaction of photons of ultraviolet light and oxygen (O_2) as shown in this reaction (which you might refer to as the ozone formation cycle):

$$O_2 + \text{Ultraviolet photon} \rightarrow O + O$$

$$O_2 + O + M \rightarrow O_3 + M^*$$

$$O_3 + \text{Ultraviolet photon} \rightarrow O_2 + O$$

(M^* = A molecule that is needed to take away the excess energy in the reaction)

Point out that the ozone in the stratosphere absorbs ultraviolet radiation, and accomplishes two things:

a. Shields the Earth from the dangerous ultraviolet photons, and
b. Participates in the ozone formation cycle in which more ozone is produced even when an a ozone molecule is broken down when it absorbs photons.

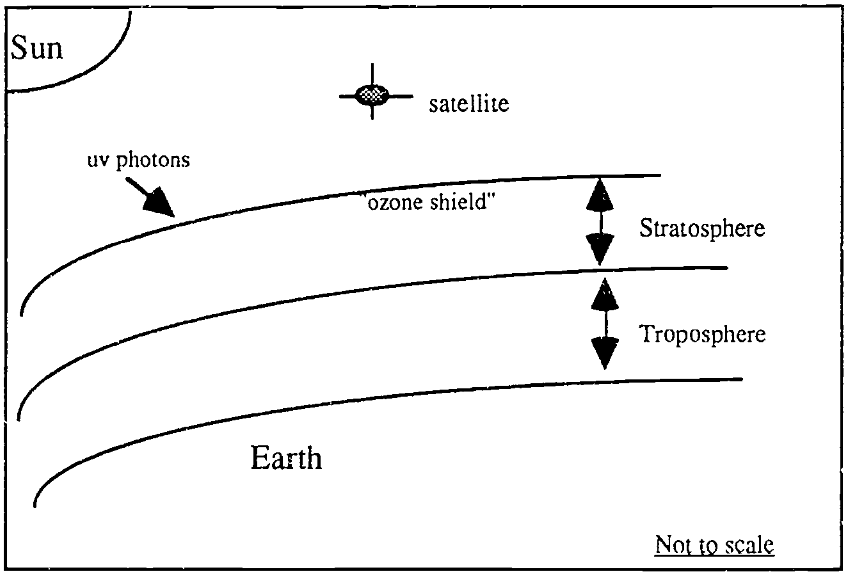


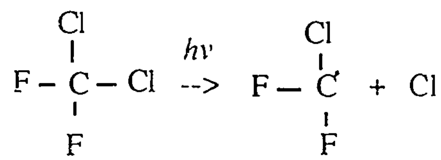
Figure 9. Troposphere and Stratosphere

3. Explain to students that the concentration of ozone in the stratosphere is very small---if it could be compacted and brought to the surface of the earth, it would be a layer about 3 mm thick. Explain to students that chemicals produced by human activity has led to the endangerment of the ozone layer. Of greatest concern are molecules known as CFCs (chlorofluorocarbons). CFCs are chemicals that have been used in hair sprays, refrigerants, and cleaning fluids. Chemically they are very stable, and consequently, they do not have to be replaced (in refrigerators) very often. However, if they are released into the environment, they will remain there for a long time.

CFCs that drift into the stratosphere react with ultraviolet photons releasing atoms that attack ozone. In the late 1970s, scientists reported this fact, and predicted a depletion of the amount of ozone if large amounts of CFCs drifted into the stratosphere. In the mid 1980s, using ground based and satellite measuring devices, scientists determined that the total column ozone over the Antarctic had decreased by 40% in a single year. This led to the concept of an "ozone hole," which has reappeared again since the mid 1980s.

In the stratosphere, the reaction that concerns scientists is as shown to the right. A photon of ultraviolet light (UV) breaks the bond holding one of the chlorine atoms to the CFC. The chlorine is released and it reacts with ozone, destroying the ozone, and creating another molecule that can in turn react with oxygen to produce free chlorine which can attack another ozone molecule. Thus an individual CFC molecule can end up destroying many ozone molecules. The reactions are as follows:

Photochemical Reaction in which UV Breaks a CFC Molecule Down



$$Cl + O_3 \text{ ---> } ClO + O_2$$

$$ClO + O \text{ ---> } Cl + O_2$$

4. Give students a number of Styrofoam spheres (or clay) and have them make the following::

- O (one sphere)
- O_2 (two spheres of same size)
- O_3 (three spheres of same size)
- CFC (three different spheres: 1 carbon, 2 chorine, 2 fluorine)
- UV photons (very tiny spheres)

Have the students use the spheres to replicate the reactions that:

a. Describe the way ozone is produced in the atmosphere
b. Describe the way ozone is destroyed in the atmosphere

Give each group the materials they need and the instructions to make molecular molecules as well as the reactions. Have each team make a display of their models, and an explanation of the their creations.

5. Have students talk about the implications of these "photochemical reactions. How does it impact their lives.

Optional Extensions

1. Have students find, read, review, and display articles in the popular press that focus on the problem of ozone in the stratosphere (ozone hole, ozone depletion). Then have them do a search of the literature in their school media center, and find several articles in science oriented journals or magazines. How do the reports compare?

2. Northern Hemisphere students might want to collaborate with Southern Hemisphere stduents, especially students living in Australia and New Zealand. The problem of ozone depletion and the ozone hole is a problem very real to the Southern Hemisphere.

Students might share information with each other, and agree to collaborate in the sharing of total column ozone data. (see Optional extension #3).

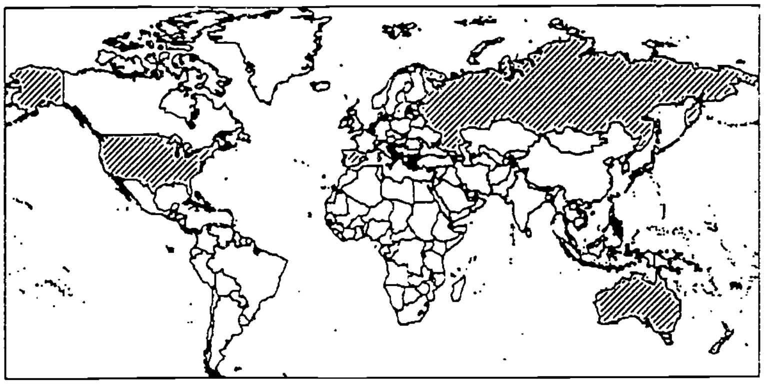


Figure 10. Northern and Southern Hemisphere schools can collaborate on the "ozone hole." Students in Australia and New Zealand can provide students in Northern Hemisphere schools with reports and opinions of the issue.

3. Collaborate with students who are working on the problem of ozone in other Global Thinking Project schools, as well as schools who are working in the Global Laboratory Project. Global Lab is a telecommunications project developed by Technical Education Research Center (TERC) in Cambridge, Massachusetts. You might want to visit the Global Lab conference that focuses on total column ozone. On EcoNet you visit this conference by typing gl.ozone. Global Lab teachers and students reporting information on gl.ozone are measuring and detecting ozone in the atmosphere using a UV probe. You might want to have your class contact some of these classes and request that they share their results.

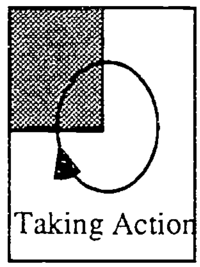
4. Students might find it interesting explore ways at the personal, local, regional and global levels for dealing with the problem of ozone depletion. What actions might and should be taken, and why would they be effective?

Ozone: What You Can Do About It?

Understanding the nature of an air pollutant such as ozone through data collection, analysis, and collaboration with other schools in the Ozone Global Community is an important step in the protection of the atmosphere. However, students can go further by becoming informed about the local and global dimensions of ozone.

You might consider using this activity as a prelude for your class' involvement in Project Earthmonth. In Earthmonth your students will be encouraged to engage in an "action-taking" project. Some teachers may find it useful to continue in the content area of atmospheric pollution. This activity makes a number of suggestions for action-taking.

Objectives



- Investigate the laws that protect the quality of the atmosphere
- Become aware of public and private groups concerned with air quality and air pollution control.
- Identify actions that students and citizens of their community can take to protect and improve the atmosphere.

Materials

phone books, newspapers, books on environmental organizations, poster paper, pens, and art materials

**Remember to check conferences on IGC, the weekly News Of Note, and the monthly IGC newsletter for resources and information on air quality and ozone.

Procedure

1. Discuss with students some ideas for brief projects that might carry out in small groups that will enable them to take action and learn to make responsible decisions concerning the atmosphere. The focus might be: How can we inform others what we have learned about ozone and air pollution. You might use the suggestions shown below as examples of projects that students might do.

Action Projects

Newsletter: Students might use the findings of their research, and the research of the Ozone Global Community to put together a newsletter that could be distributed to others (students, parents, teachers citizens) in their local community.

Video Program: A team of students might want to produce a consumer-type video tape that informs the public about ozone, and how the problems associated with tropospheric and stratospheric ozone can be resolved. The video program could be presented to other classes in the school, or to citizen groups in the community.

Poster Reports: Students might create poster reports of the work they did in Project Ozone in which they display work done by their class and other classes in the Ozone Global Community. Poster reports can be displayed in the school, and in the community.

Research Paper: Some groups might be interested in writing brief research papers that describe the investigations they conducted in Project Ozone. Students might try and get one or more schools in the Ozone Global Community to collaborate. A final product might be a collection of students papers bound together as a final report.

2. Cooperative groups should meet to decide what kind of project they will work on. This might involve making contacts with government agencies, or environmental groups. The students might also want to investigate other online conferences on the IGC Networks. To search the Network for other online conferences, connect to IGC manually, and then follow the procedures below: The conference directory is found b y selecting (l)ist from the "Conf?" prompt:

```
Conf? l <enter>    (that's a lower case "L")
-----conference directory-----
Network: (a)ll, (o)ther, or <enter> for EcoNet (? for help):

Enter name, keyword, or <ENTER> for all (? for help):
```

(At this point, enter a single word of interest (such as ozone), or hit <ENTER> for a complete list. The next prompt is:

```
Do you want: a (b)rief, (m)edium, or (c)omplete listing (? for help):
```

A search of all the conferences with the keyword "ozone," took only a few seconds, and displayed the following:

```
bit.listserv.biosph-l   en.climate   gain.toxics
gef.forum   gef.report   gl.ozone   gl.tech

7 conferences listed for keyword ozone
```

3. Students should finalize their projects, and then make reports to the class. Cooperative teams should write brief summaries of their projects, and share them with members of their Global Community.

Project Earthmonth

Project Earthmonth is a culminating activity of the Global Thinking Project. During the year, students have been learning how to investigate environmental problems, and how to use telecommunications to collaborate with students around the world. During Earthmonth, which traditionally is held during the month of APRIL, the Global Thinking Project invites your classes involved some kind of action taking project. Responsible environmental action can be individual or collective. There are various types of environmental action strategies including:

Consumerism: buying something that represents a decision reflective of one's position on an environmental issue, or not buying something that represents a decision contrary to one's position on the issue.

Persuasion: convincing others, individuals and groups, that a suggested course of action is correct.

Political action: bringing pressure on political or governmental agencies and/or individuals in an effort to influence positive environmental action.

Eco-management: taking action to maintain a good physical environment or to improve a weakened physical environment.

During this Phase (III) of the Project, your school will continue to collaborate with the Global Community of practice that you were part of during Phase II. Although you were investigating Solid Waste, Ozone or Water Pollution, the content of your action projects is not limited to solid waste, ozone or water. The action project should be an opportunity for your students to apply the skills of research, telecommunications, data analysis and collaboration to an action taking project that they want to work on.

Below you will find a number of suggestions for types of projects that your students might find interesting. However, we recommend that you plan to conduct a session in which students suggest possible action-taking projects, and use your facultative skills to guide them to worthwhile endeavors.

Objectives

• Participate globally in action-taking projects designed to focus on environmental issues and problems

• Identify an environmental problem or issue, and design an action-taking project to help resolve the problem

Materials

Materials will vary for different projects. Students may need access to video cameras, multi-media experts, poster paper, drawing instruments, magazines, newspaper, phone books, names of government agencies (see phone books).

An excellent reference book is:
The Student Environmental Action Coalition, 1991, *The Student Environmental Action Guide: 25 Simple Things We Can Do.* Berkeley, CA: EarthWorks Press.

Procedures

1. Around mid-March, conduct a brainstorming session with your students identify possible Earthmonth action-taking projects. Divide you class into groups and provide each group with chart paper and writing tools to use to record their ideas for projects. Pool the groups' ideas onto a class Earthmonth master table. You should decide with your students whether the whole class will work on single project, or whether each group will work on separate projects.

Figure 1. Projects Suggested by Global Thinking Teachers, Summer 1993

Adopt an endangered animal
GTP Students share projects
T-Shirts
Adopt a stream or highway
Environmental 'tip' of the day
Measure solid waste for one day
Monitor and make suggestions for improvement
Invention convention on new ways to reuse things
Write someone in authority newspaper
Daily or weekly "eco-report" to school
Recycle art project
Create environmental displays
Raise money to buy an acre of rainforest
Project clean-up
Life story of a product
Bulletin board contest
Science fair with recycle/Earth theme
Restore waterway bank
Video of projects---show within school
Poster contest
Weekly class award for kindness to Earth
Plant trees/flowers
Newspaper for school or public
Positive 3 R's examples
Share on Earth conference
Endangered animals resource-based unit
Students write skit or play
Environmental collage
Contest to collect recyclables
Let students decide
Guest speaker
Film festival
Invite a reporter to class
Field trip---EPA, treatment plant
Display of schools involved worldwide
Give a helping hand
Environmental for a day
Poetry/rap contest
Photo essay on environmental theme
Personal contract/commitment
Approach a business
Involve parents
United news contest

2. Send a report to the schools in your Global Community and to the gtp.earthconf. This will enable all schools in the project to learn from your students' thinking. Be sure to download and print copies of other schools' projects. Post the results on a master table as shown in Figure 2. Use this data to help students determine possibilities for collaboration with other schools.

Figure 2. Earthmonth Projects in our Global Community

Global Community School	Suggested Project(s)
Moscow 710	
Yaroslavl 22	
Salem Jr. High	
Shiloh Middle School	
Centre Education Projecte	
Oberon High School	
Hilo Intermediate School	
North Heights	

3. During the month of APRIL establish a schedule to help guide the students through their action-taking project. Figure 3 outlines some steps that you might find helpful.

Figure 3. Steps for Action-Taking Projects[1]

Procedure	Activity
Problem Identification	Students brainstorm possible problems or situations to improve the local community.
Fact-finding	Students find out information to understand why the problem exists. They are informed that they can obtain information from (1) community resources (2) national and international organizations (3) opinionnaires (4) resource people (5) independent group study (6) IGC conferences
Problem selection and definition	Students choose one or two problems that if solved could make the biggest difference. They must decide if they have the tools and resources available to successfully solve the problem. Students might want to consider the content areas they have studied in the Global Thinking Project, e.g., clean air, solid waste, ozone, water watch.
Brainstorm solutions	Students generate as many solutions to the problem as possible. Students might also want to invite some other schools to help them brainstorm solutions by using the telecommunications Network.
Evaluating solutions	Students rank-order the effectiveness of their solutions and choose the top two to three ideas. They list criteria to help them decide what might be the best solution. Criteria include, Will the solution make a long term difference? Are there adequate resources to help them in acting on their solution?
Taking Action	In this step, students decide the different ways to carry out their solution. They decide which strategies (consumerism, persuasion, political action, eco-management) will be most effective. They create a time line and plot the course of action.

[1] Excerpted from Micki McKisson and Linda MacRae-Campbell, *No Time to Waste! The Greenpeace East-West Educational Project, Teacher Guide* (Washington, D.C.: Greenpeace International, 1989), p. 23

4. Student groups should report the results of their action-taking projects to other members of their Global Community, and the gtp.earthconf.

5. Students should also share their results with their school and/or community. They might plan a Global Thinking Earth (day) activity to communicate their work.

Global Thinking Resources

This section of the handbook includes background information on the content of the Global Thinking projects, as well as references that might be valuable to you and your students.

Contents

Notes On Tropospheric Air Pollution

Diane Jacobi
Georgia Institute of Technology

General Information

-pollutants are chemical species that are not normally found in a "clean" atmosphere (nitrogen, oxygen, carbon dioxide, water, and inert gases)

- pollutants can be either gases or particulates (solid or liquid);

-there are *primary* and *secondary* pollutants: *primary* pollutants are the species that enter the atmosphere directly from identifiable sources: *secondary* pollutants are species that form from the chemically altered primary pollutant

-there are natural sources of both primary and secondary pollutants: volcanoes, forest fires, plants (pollen and off-gassing of other chemicals), wind blown dust, and breaking waves are a few of the natural primary sources.

-pollution can be a local, regional, or global problem; factories can be a local and/or regional problem depending on the pollutant emitted and the height of the smoke stacks (higher stacks increase atmospheric residence time, therefore allowing for a longer travel distance)

- the worst pollution incidents usually occur during temperature inversions (pollutants do not mix with the upper troposphere.

Sulfur Oxides and Particulate Air Pollutants

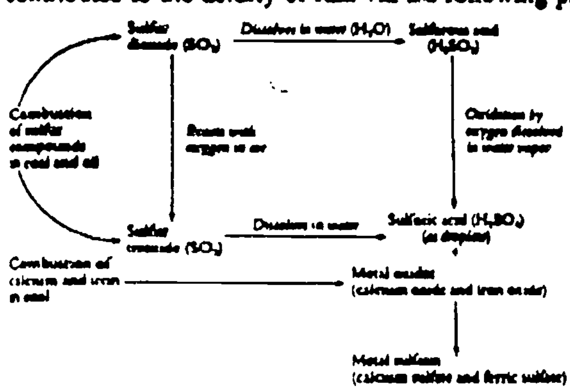
-atmospheric sulfur compounds are mainly from fuels rich in sulfur, such as coal and heating oils (natural gas and gasoline are virtually sulfur free) (burning of all fossil fuels will increase CO_2 concentrations)

- sulfur is released to the atmosphere mainly as sulfur dioxide gas (SO_2)

-sulfur dioxide has a residence time on the order of weeks

- sulfur dioxide released to the atmosphere is mainly from man-made sources

-sulfur dioxide contributes to the acidity of rain via the following process:



-in dry conditions $SO_2 \rightarrow SO_3$; in humid conditions $SO_2 \rightarrow H_2SO_3$

- sulfur compounds can also increase particulate pollution in the atmosphere:

$$H_2SO_4 + \text{metal oxide} \rightarrow \text{metal sulfate particulates}$$

-sulfate particulates are relatively small compared to other atmospheric particulates; therefore they will be suspended for a longer time period.

-high ozone concentrations enhance the conversion of SO_2 to sulfuric acid via the reaction path:

$$SO_2 + O_3 \rightarrow SO_3 + O_2$$
$$SO_3 + H_2O \rightarrow H_2SO_4$$

-sulfuric acid will damage: limestone, marble, mortar, steel, copper, aluminum, synthetic and natural fibers, and plant life.

Particulate Pollution

- particualtes can settle on surfaces

-can act as cloud condensation nuclei : this can increase fog, clouds, and/or rain depending on metrological conditions

-particulates can also increase acid rain when in the presence of sulfur oxides; this happens because the particulates act as CCN, which then form droplets. The sulfur oxides then readily dissolve into the existing droplets.

-particulates can substantially reduce visibility which can increase accidents

-particulates will reflect incoming radiation

-smog- is a combination of smoke and fog: it is this type of pollution that created the famous "fogs" of Victorian London. Smog is general at its worst when there is a high concentration of both particulates and sulfur oxides.

Pollutants from Automobiles (Photochemical Smog)

- automobiles release a number of compounds to the atmosphere; the majority being CO, CO_2, and nitrogen oxides.

- Carbon monoxide (CO) is produced by the incomplete oxidation of carbon during the combustion process:

$$2C + O_2 \rightarrow 2CO$$

-complete combustion of carbon produces CO_2

$$C + O_2 \rightarrow CO_2$$

- Carbon monoxide creates a significant health threat because it ties up hemoglobin (the substance which transports oxygen through the body); CO has about a 200 times stronger bond to hemoglobin than does oxygen.

-cigarette smoking is the most dangerous pollutant one can inflect on oneself; cigarette smoke contains not only numerous known carcinogens, but also has enough carbon monoxide to worsen coronary and respiratory problems. A moderate smoker can tie up more than 6% of his hemoglobin to CO.

-the release of CO per mile driven has dropped from about 73 g CO per mile in 1960's to only 3.4g CO per mile in 1981. This has helped to increase the air quality in many major cities.

-photochemical air pollution is a secondary pollution occurring mainly from the interaction of vehicle exhaust fumes and sunlight.

- The reactions for photochemical air pollution are as follows:
  1. During the night and early morning rush hour nitrogen oxide concentrations increase
  2. Once the sun has risen, the nitrogen oxide is converted into nitrogen dioxide via a photochemical path
  3. The nitrogen dioxide proceeds through a series of photochemically reactions with other compounds (such as hydrocarbons) to form ozone.

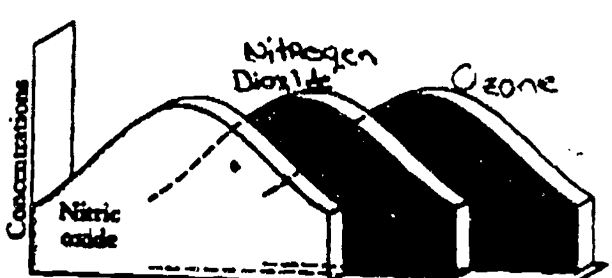


Figure 21.4 Levels of nitric oxide, nitrogen dioxide, and ozone during and after the morning "rush hour."

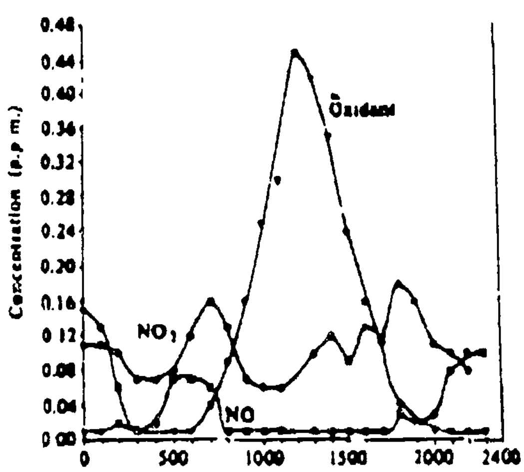


Fig. 5.8. Variations in concentration of oxidant (mainly ozone) and oxides of nitrogen during the course of a smoggy day in Southern California. [Source: Finlayson-Pitts, B. J. and Pitts, J. N., Jr. *Adv. Environ. Sci. Technol.* 7, 75 (1977).]

-Photochemical smog usually appears as a yellow brown fog; Los Angeles is famous for this type of smog. The orographic features of LA contribute to the formation of temperature inversions, which allows for the build up of these compounds.

-During the summer, Atlanta usually has very high ozone concentrations. This is because of the large amount of incoming radiation, high volume of traffic, and the large number of pine trees in the city. Pine trees emit hydrocarbons known as terpenes, These compounds greatly enhance the conversion of NO_2 to ozone.

-lead is a compound that use to be released largely from automobiles, but with the incorporation in 1986 of a limit of 0.1 g of lead per gallon of gasoline (down from 2.5 to 4.5 g of lead per gallon previous to 1975), automobiles no longer add substantial amount of lead aerosols to the atmosphere.

-<u>Health Effects</u>

-most pollutants enter the body through the respiratory system; some of the solid pollutants may enter or be swept into the gastrointestinal system

- pollution episodes during inversions can last for days:

Examples of "smog": Donora, PA October 1948
4 day inversion; heavy "fog" (smog); 20 deaths attributed to the smog and many more illnesses

London, 1952
5 day inversion; over 4,000 related deaths

-it is difficult to assess impact on human health because controlled studies cannot really be done.

-the presence of both particulate and sulfur oxides creates a much greater health risk than the presence of just one

-carbon monoxide concentrations of just 10 mg/m^3 can substantially alter how well a person is able to react to his or her surroundings.

-in rush hour traffic CO levels can reach well above 60 mg/m^3; some scientist theorize that many accidents may be due to increased levels of CO in the bloodstream, decreasing performance levels.

-ozone is a carcinogen when it is brought into the lungs

MAJOR MAN-MADE AIR POLLUTANTS

Pollutant	Description	Sources	Effects
Carbon monoxide (CO)	• colorless, odorless gas	• vehicles burning gasoline • indoor sources include kerosene- or wood-burning stoves	• headaches, reduced mental alertness, death • heart damage
Lead (Pb)	• metallic element	• vehicles burning leaded gasoline • metal refineries	• brain and kidney damage • contaminated crops and livestock
Nitrogen oxides (NO_x)	• several gaseous compounds made up of nitrogen and oxygen	• vehicles • power plants burning fossil fuels • coal-burning stoves	• lung damage • react in atmosphere to form acid rain • deteriorate buildings and statues • damage forests • form ozone & other pollutants (smog)
Ozone (O_3)	• gaseous pollutant	• vehicle exhaust and certain other fumes • formed from other air pollutants in the presence of sunlight	• lung damage • eye irritation • respiratory tract problems • damages vegetation • smog
Particulate matter	• very small particles of soot, dust, or other matter, including tiny droplets of liquids	• diesel engines • power plants • industries • windblown dust • wood stoves	• lung damage • eye irritation • damages crops • reduces visibility • discolors buildings and statues
Sulfur dioxide (SO_2)	• gaseous compound made up of sulfur and oxygen	• coal-burning power plants & industries • coal-burning stoves • refineries	• eye irritation • lung damage • kills aquatic life • reacts in atmosphere to form acid rain • damages forests • deteriorates buildings & statues

Water Quality Notes

River Wach Network[1]

I. What Is Water Quality?

The objective of this act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Federal Clean Water Act, 1972

That statement from the Clean Water Act eloquently describes water quality and our Nation's relationship to it. It says that the water quality of a river is a combination of all of its **physical**, **chemical**, and **biological** characteristics. It says that "integrity" or wholeness should be the condition of our waters. It also acknowledges that humans have abused our waters so that there is a need to restore their ecological integrity.

A. River Basics

The **physical** layout and foundation for a river community is flowing water and its relationship to the land area that drains into the river – its watershed. It's water rushing through a gorge, or flowing lazily through a farm meadow. It's a physical process, cutting its channel through rock and soil, and carrying the eroded material downstream. The river's **chemical** characteristics are the basic building blocks for a river community. These are the water's oxygen content (dissolved oxygen), acidity (pH), ability to neutralize acid (alkalinity), nutrients, metals, and other constituents. In the absence of human influence, the water chemistry is determined by the soils and rocks in the watershed, the chemistry of the precipitation, and interaction with plants and animals on land and in the water. It profoundly affects, and is affected by aquatic organisms. The **biological** inhabitants of river communities are wonderfully varied – from single-celled plants and animals, aquatic insects, and other small residents, up through large fishes. Flowing water is the thread that binds this living community together within itself and with the surrounding land.

B. The River Community's Foundation

Rivers change as they flow from the headwaters to the mouth. They may flow through a variety of land types and land uses. Generally, rivers are divided into "reaches:" The **Upper Reach or headwaters** is the small stream or streams that are the beginning of the river, at higher elevations at the rim of the watershed. In undeveloped mountain areas, they are usually in forested areas that shade most or all of the stream, cold, and fast-moving. The stream bed is mostly rock and large cobbles. At the other extreme, low-lying coastal rivers may begin in cleared wet areas, and the stream may not drop very far to sea level. The beds of these streams may be primarily sand and silt. In either case, these headwater streams join others to form the **mid-reach.** Here the stream becomes much wider and is no longer totally shaded by vegetation. In agricultural or developed areas, there may little or no bank vegetation. The river current slows in places, forming pools, and the water may be warmed considerably by the sun. The bottom may vary from rock and cobbles, to sand and gravel. The **lower reach** is the slow-moving part of larger rivers. These are deeper, frequently muddier, and have mud or silt bottoms. They join a larger water body at their **mouth.**

Another way to look at this change is a numerical ordering scheme called **stream orders.** As streams increase in flow and join other streams, a branching network is established. Stream orders describe the relative position of a stream within a river system. The headwaters or upper

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[1] From River Watch Network. 153 State St.. Montpelier. VT 05602

reach is a **1st order stream.** Two first order streams join to form a **second order stream**, which joins another second order stream to form a **3rd order stream**, and so on. In the stream reach system described above, the upper reach might be stream orders 1-3. The mid-reach might be stream orders 4-5. The lower reach might be orders 6-10. The Mississippi river near its mouth, for example, is considered a **12th order** river.

The "Stream Orders and Reaches" diagram illustrates stream orders and reaches and the changes that occur in the stream from headwaters to lower reaches.

C. How River Communities Work

How does this community work? The diagram shows many of the inter-relationships within the community from headwaters to mouth. The left side of the diagram shows the stream order and the river width (in meters). The large circles show the composition of the benthic macroinvertebrate community. These are aquatic invertebrates (mostly insects) that spend at least a part of their life cycles on the river bottom. The various drawings show other parts of the river community. Let's start at the top:

A leaf falls into a small stream high in the mountains. Here the river is narrow and shallow. This leaf is called "CPOM" (coarse particulate organic matter). It is quickly attacked by bacterial and fungal "decomposers" ("microbes" in the diagram). Some of the nutrients in the leaf are dissolved into the water, and flow downstream until taken up by aquatic plants or decomposers. Aquatic insect "shredders" (such as caddisfly larvae and snails) feed on the leaf and its attached "frosting" of decomposers. Meanwhile, "grazers" (such as mayfly nymphs) feed directly off living aquatic plants ("producers" in the diagram). Grazers and shredders reduce plant tissue to smaller particles, some of which is used by the insect to grow. Excreted or unused food is washed downstream. This "detritus" or "FPOM" (fine particulate organic matter) provides food for the "filtering and gathering collectors" such as certain mayfly nymphs, certain caddisfly and black fly larvae and worms, which are waiting downstream to catch a meal. The insects themselves provide food for other predatory insects and fish. The top pie diagram shows that the aquatic invertebrate community at the headwaters is dominated by shredders and collectors. The "P/R <1" refers to oxygen producers versus respiration (oxygen consumers). In the headwaters, this ratio is less than 1, since there are more respirers than producers and the biological community is consuming more oxygen than it produces. Fortunately, the cold, falling water more than replaces this oxygen.

As the river flows downstream, some organic material is stored (as insect or animal tissue), some is cycled (changed to different forms), and some is released to flow downstream. Downstream aquatic communities take advantage of inefficiencies upstream. The composition of the macroinvertebrate community changes to reflect the different type of food available. In the mid-reach, the macroinvertebrate community is dominated by collectors and grazers, since the main food source is changing to FPOM and periphyton (attached algae) and the physical habitat is changing to slower, deeper pools. Since oxygen-producing plants are now plentiful, the P/R ratio is now greater than 1 – the biological community is now producing more oxygen than it consumes.

Finally, the lower reach is very wide, deep, and the macroinvertebrate community is completely dominated by filtering collectors that feed on FPOM. The river is too deep for most aquatic plants, and so the p/R ratio becomes less than 1 again.

River communities are not homogeneous, nor are they static. A river community changes dramatically from its headwaters to its mouth, from season to season, and from year to year. However, healthy rivers are remarkably stable communities. What provides this stability is a diversity of organisms. Since many aquatic organisms are opportunistic, they can adapt to changes in the food supply. This diversity means a menu of food choices for aquatic life. If these choices are reduced, because of alteration of the physical or chemical parts of the ecosystem, the community will become less diverse. Organisms that are most effective at using the remaining food source will dominate, others may disappear. Serious disruptions may eliminate large portions of the community.

D. Human Impacts On Rivers

The "Human Impacts On Rivers" diagram illustrates some of the impacts humans have had on rivers.

Sewage: Human sewage comes from wastewater that we generate in our homes. It can get into rivers from wastewater treatment plants or on-site septic systems that aren't operating properly. Sewage consists of partially decomposed organic material, nutrients, and bacteria that your body doesn't use. When this material gets into rivers, it is attacked by bacteria which decompose it. This process uses oxygen from the water, creating an **"oxygen demand."** If there is enough material, the bacterial action can deplete the oxygen in the water and deprive aquatic organisms of an essential element of survival. Sewage also contains nutrients, particularly **nitrogen** and **phosphorus.** Excess nutrients can accelerate the "aging" process of a river by causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in the river. This, in turn, affects dissolved oxygen, temperature, and other river characteristics (see the description of these below). Sewage also contains **pathogenic micro-organisms** – things like bacteria and viruses which can make you sick if you come in contact with them by swimming, for example.

Nutrients: In freshwater rivers, the two main nutrients of concern are **nitrogen** and **phosphorus.** Nutrients come from a host of sources:wastewater treatment plants, runoff from fertilized lawns and crop land, failing on-site septic systems, runoff from animal manure storage areas, disturbed land areas, drained wetlands. Excess nutrients can accelerate the "aging" process of a river by causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in the river. This, in turn, affects dissolved oxygen, temperature, and other indicators. **Phosphorus** is an essential plant and animal nutrient. Total Phosphorus includes organic and inorganic forms. Organic phosphorus occurs in living plant and animal tissues and is not readily available to stimulate aquatic plant growth. The inorganic form, ***phosphate,*** is readily usable by aquatic plants, and is the form of phosphorus most likely to have an immediate impact. Decomposition converts organic phosphorus to phosphate. When used by plants, phosphate is again bound in plant tissue. In most waters, phosphorus is the limiting factor in aquatic plant growth since it naturally occurs in very low concentrations. **Nitrogen** is an essential plant and animal nutrient. It cycles through many different forms in aquatic ecosystems. The ***Ammonia*** (NH_3) and ***Nitrate*** (NO_3) forms are the most usable by aquatic plants. Aquatic plants do not respond as readily to nitrates as they do to phosphates, since nitrates are relatively plentiful in the aquatic system. Nitrates may become toxic to warm-blooded animals under certain conditions.

Toxic Substances: Toxic substances include a wide variety of substances which interfere with metabolic, physiological, genetic, or reproductive activities of humans and aquatic organisms. THEY KILL! Some are toxic to humans and aquatic life at very low concentrations. Many are extremely persistent in the aquatic environment and increase in concentration as they pass up the food chain: bio-magnification (active) or bio-accumulation (passive). Others are bound up or transformed into less-harmful substances. The fate of many are unknown. Sources include runoff from areas where pesticides are applied, industrial and municipal discharges, landfills, old dumps, urban runoff, etc. Examples include **pesticides** like DDT and DDE; **plastic production by-products** like PVC's and PCB's; **metals** like copper, zinc, chromium, and cadmium; and **radiation.**

Sediment: Sediment consists of include organic and inorganic particles suspended in the water, such as silt and clay soil particles, plankton, industrial wastes, and sewage. Sediment is carried into rivers by overland runoff from construction sites, urban areas, agricultural land, logging sites, and eroding river banks. When it gets into the river, it is suspended in the water column until it settles out. Sediment suspended in the water column causes the water to absorb sunlight and warm up faster and can disrupt respiration in aquatic organisms by clogging their gills. When it settles on the river bottom, sediment may cover cobble and gravel areas which are valuable fish-spawning and aquatic insect habitat. Sediments may also carry toxic substances, nutrients (see nitrogen and phosphorus), and other substances harmful to aquatic life and human health.

Flow Changes: **Impervious road, parking lot and roof surfaces** speed up the over-land flow of water, which means more water gets to the river faster. Higher flows, more channel scouring, and more erosion (since there's more energy and soil particle-dislodging potential) are the result. Asphalt surfaces also heat the water, so the water entering the river may be warmer than the river water itself. A **dam** changes the physical foundation of the river when it replaces rapids and cascades with a reservoir. Above the dam, water velocity is slowed, causing soil particles and organic material to settle to the bottom and cover the river bed with mud. Oxygen levels are reduced as the organic material, which previously flowed downstream, decomposes. At the same time, oxygen is not replenished as quickly in the reservoir as it was in the white water. Downstream of the dam, the flow may fluctuate dramatically, if it is daily stored and released daily. Habitat areas may be left high and dry at times. The food supply from upstream is reduced. Fish which migrate upstream to spawn may not be able to get over the dam. **Water withdrawals** can reduce flows, causing higher temperatures, lower water levels, and other direct effects on river habitat.

Cumulative Impacts: Remember that many of our rivers have many or all of the above impacts. Taken together, their cumulative impact may be far greater than the individual impacts, as they interact and magnify each other. The net result may be loss of aquatic habitat, a less diverse and stable aquatic community, and a river which is less desirable for human use.

II. The Water Quality Study

Water quality is the sum total of all of the above: the river's physical, chemical, and biological integrity and the interaction among them. So how do we study this complex system? There are almost an infinite number of chemical and physical "pollutants" that may alter water quality and impair the health and integrity of the aquatic-life in a river or stream. We can, however, look at some of the important "water quality indicators" to help us answer a study question.

While this guide is geared toward a water quality impact assessment, other types of studies are possible. Even within the impact assessment, there are many ways of carrying out the study. We have selected several water quality indicators which have been shown to work well in schools. However, the specific study design can be tailored to the issues, goals, and resources available to each school. This section describes the process for doing that.

A. Identifying Human Alterations of the River (e.g. pollution source), Study Goals, and Study Question

The impact assessment is geared to evaluating the impact of a specific human alteration on selected water quality indicators. The first step is to identify the human alterations of the river, or segment of river, that might be evaluated. These may be dams, pollution discharges, channel alterations, or any of the human impacts described in Section I.D. above.

Based on the human impact identified, it is important to develop a clear set of study goals. Educational goals should also be identified. Finally, the study question is posed. Below are some examples.

Study Goals:

1) To evaluate the impact of a selected human alteration on the aquatic community of a segment of the stream..
2) To assure that the water samples collected are representative of the river reach being tested.
3) To assure that the samples can be collected safely.
4) To become familiar with procedures for collecting and analyzing information on the physical, chemical and biological characteristics of a stream.

Educational Goals:

1) To learn about the aquatic ecosystem of the stream.
2) To learn selected water quality sampling and analysis techniques.
3) To learn quality control/quality assurance techniques
4) To learn how to evaluate data in terms of **a)** what's going on in the stream, and **b)** what's going on in the lab.

Study Question:

What is the impact of the selected human alteration on the physical, chemical (dissolved oxygen, pH and alkalinity) and biological (Benthic Macroinvertebrate Community) integrity of the stream?

B. Locating Study Sites

Selecting the right monitoring sites is a very important part of the water quality study. In an impact assessment study, it is very important that the sites selected are as similar in all aspects – except the impact being assessed – as possible. In order to select the right sites, it is important to understand the natural variations in a stream as it travels from its source to its confluence with a larger brook or the ocean. This is described in section I. of this guide.

When selecting sites, we must bear in mind the different reaches or stream orders. Natural variations in water quality occur as one moves from the headwaters to the mouth. Therefore, if we're trying to determine the impact of pollution on a stream, we should select sample sites that are within the same reach, so that natural variations don't affect our results.

Bearing in mind the study goals, we will focus on sites which "bracket" the human alteration and which are convenient and accessible to the school.

Siting Criteria:

1) Bracket the human alteration with three sites:
   - **Impact Site:** One station should be located immediately downstream of the alteration at the point where the impact is completely integrated with the river water.
   - **Reference or Control Site:** This site is located immediately upstream of any potential impact from the alteration being evaluated, and
   - **Recovery Site:** This site is located downstream stream of any potential impact from the alteration being evaluated, where the river has recovered from the impact. Ideally, this site should not be influenced by other river alterations either.

   It is very important to attempt to match these physical characteristics between stations in an impact assessment study.

2) Sites which are reasonably close to the school and safely accessible. Avoid steep, slippery or eroding banks or sites where landowner permission cannot be obtained.

3) Sites for macroinvertebrate collection should be shallow (1-2' deep), "riffle" areas with good (but not too strong) current, and rocky/gravelly bottoms.

4) Collection sites should be located in the main brook current and away from the banks. If that is not possible, locate the site next to the bank where homogeneous mixing of the water occurs, such as on an outside bend of the brook.

5) Collection site locations should consider variable flow patterns caused by artificial physical structures such as dams, weirs, and wing walls. These may influence the representative quality of the water.

See the "Guide To Macroinvertebrate Sampling" for a more detailed discussion of locating macroinvertebrate sites.

Documenting and Field Checking Sites:

All collection sites should be field-checked to verify that they are accessible and meet the conditions described in the preceding sections. Next, detailed directions on how to find each site should be drafted. All sites should be located on a U.S.G.S. topographic map. The idea is that all samplers should have no trouble locating the sample site to assure that the same sites are sampled each time.

C. Collecting and Recording Visual Observations of the Physical Characteristics

We will measure ᵓd visually observe some of the river's important physical characteristics: temperature, depth, width, velocity, the materials that make up the brook bed, the amount of shading by brook bank vegetation, erosion, human modifications of the channel or bank, and others. These characteristics are the foundation for the brook community. Physical observations will be recorded on field sheets provided in the "Guide To Macroinvertebrate Sampling."

D. Collecting and Analyzing Water Samples for Dissolved Oxygen, pH, Temperature, and Total Alkalinity

The water samples for dissolved oxygen will be collected in 300 mL, glass-stoppered "BOD" bottles and "fixed" in the field according to procedures which accompany this guide. The water samples for total alkalinity will be collected in 250 mL polypropylene screw-top bottles and returned to the lab for analysis. pH will be measured in the field using a Hach "Pocket Pal" pH meter. Temperature will be measured using an armored, alchohol-filled thermometer.

Laboratory analysis for dissolved oxygen and alkalinity will be carried out according to procedures which accompany this guide. For dissolved oxygen, the Hach Azide Modification of the "Winkler" method using Hach reagents and a digital titrator will be used. For total alkalinity, the sulfuric acid digital titration method will be used.

The results of the chemical monitoring will be compared with State Water Quality Standards and U.S. E.P.A. Water Quality Criteria. See Section VII.

E. Collecting and Analyzing Benthic Macroinvertebrate Samples

Macroinvertebrate samples will be collected using the "kick net " method and lab procedures described in the "Guide To Macroinvertebrate Sampling." Samples will be transferred in the field to 1 qt. jars, preserved, and returned to the lab for analysis. Lab analysis will consist of picking at least 100 organisms from the sample, sorting, and identification to the order or family level, and using several indices to interpret the results. These indices and their interpretation are described in the "Guide To Macroinvertebrate Sampling."

F. Developing a Set of Findings, Conclusions, and Recommendations

Participants will analyze the data and develop a set of **findings** (observations of trends and patterns from the data), **conclusions** (identification of problems and possible causes to answer the study question) and **recommendations** (for further study or action).

G. Student Presentations of the Results of the Study at School and Public Gatherings

Participants are encourage to present their findings, conclusions, and recommendations at school and public gatherings. These can be organized by a community group or the school.

III. A Brief Look At the Water Quality Sampling Procedure

Students and teachers from participating schools will collect and analyze water and macroinvertebrate samples in late May and September from a local river or stream to determine the impact of a human alteration of the river on the chemical and biological integrity of the water. The general procedure will be as follows:

1) Physical observations, water and macroinvertebrate samples will be collected from at least two sites on the river or stream above and below the alteration being studied using procedures described in accompanying material. Measurements for water temperature, velocity, width, depth, and pH will also be taken in the field.
2) Physical observations will be recorded on field sheets provided in the "Guide To Macroinvertebrate Sampling."
3) The water samples for dissolved oxygen will be collected in 300 mL, glass-stoppered "BOD" bottles. Samples will be "fixed" in the field.
4) The water samples for total alkalinity will be collected in 250 mL polypropylene screw-top bottles and returned to the lab for analysis.
5) Macroinvertebrate samples will be collected using the "kick net" method described in the "Guide To Macroinvertebrate Sampling." Samples will be transferred to 1 qt. jars, preserved, and returned to the lab for analysis.
6) Water and macroinvertebrate samples will be analyzed in the lab using procedures described in accompanying material.

IV. A Brief Descriptions of the Water Quality Indicators Used By the River Watch Program

[redacted]

What Are They? The benthic macroinvertebrates are those aquatic invertebrates that live at least part of their life cycles in or on the bottom substrate of a body of water. Since they are very sensitive to changes in the physical and chemical nature of their habitat they serve as an excellent indicator of the overall environmental quality of a river or stream. In water quality surveys, the macroinvertebrates considered are usually limited to those organisms that will not pass through a Number 30 U.S. Standard sieve (mesh size 0.59 mm). Examples of these organisms are: crayfish, snails, clams, worms, leeches, and aquatic insect larvae such as Stoneflies, Mayflies, and Caddisflies, etc. (see Appendix 1 and Key to the Freshwater Macroinvertebrate Fauna of New England for brief descriptions and illustrations of these organisms).

Why Are They Good Water Quality Indicators? Benthic macroinvertebrates are good water quality indicators for several reasons:

1. **They are relatively easy to sample:** Macroinvertebrates are abundant and visible to the unaided eye, are relatively immobile, and have 1-2 year life cycles.
2. **They are continuous monitors of environmental quality:** Macroinvertebrate communities contain many organisms, each with its own preferred environmental conditions and life history. The structure of this complex community – the type and abundance of organisms found – reflects the physical and chemical conditions of the water. Changes in these conditions (due to pollution, dams, etc.) are, therefore, reflected in the community.
3. **They are a critical part of the food web.** Macroinvertebrates form a vital link in the food chain between aquatic plants and organic detritus (i.e. algae, and leaves, etc.) and the upper levels of the food chain including the highly valued game fish species (such as trout) of our rivers and streams.

What Do They Tell Us About the Health of the River? The structure of the macroinvertebrate community can reflect the following conditions in a river or stream:

- The general overall water quality
- The effects of nutrient and organic enrichment from point and non-point pollution sources,
- The effects of toxic contamination from point and non-point pollution sources,
- Differences in physical habitat conditions caused by changes in flow, stream-side vegetation, channelization, and other human alterations of the river.

[illegible]gen (DO):

What Is It? Dissolved oxygen is a measure of the oxygen in solution in the water. Oxygen enters the water from the atmosphere and is produced by aquatic plants undergoing photosynthesis. DO is measured in milligrams per liter (mg/l) or % saturation. % saturation is the amount of oxygen (mg/l) in the water relative to the amount of oxygen the water can hold (the "maximum saturation"). The maximum saturation varies with temperature: cold water can hold more oxygen than warm water.

Why Is It A Good Water Quality Indicator: Most aquatic plants and animals need dissolved oxygen in the water to survive. Some, like trout, require relatively high levels. Others, like carp, require relatively low levels. Dissolved oxygen is consumed by decomposing organic materials and by aquatic animals as they respire. This consumption is referred to as an "oxygen demand." If the oxygen demand exceeds the oxygen supplied by the atmosphere and produced by plants, dissolved oxygen levels decrease.

What Can It Tell Us About the Health of the river? Too little oxygen, or dramatic changes in oxygen levels in the water can cause fish to suffocate and severely reduces the diversity of organisms that live in the brook. Low dissolved oxygen levels can be caused by the presence of sewage or other human-caused "organic enrichment" of the stream.

C. pH

What Is It? pH is a measure of the hydrogen ion concentration in water or the equilibrium achieved by various "acid" or "alkaline" compounds, salts, and gases. pH is measured on a scale from 0 (most acidic) to 14 (most alkaline), with 7 considered "neutral." It is important to keep in mind that the pH scale is an exponential scale. Therefore, a pH of 6 is ten times more acidic than pH 7, a pH of 5 is one-hundred times more acidic, and so on.

Why Is It A Good Water Quality Indicator? Different organisms have different ranges of pH within which they flourish. The pH of a stream can be changed by atmospheric deposition (acid rain), surrounding rock, discharges.

What Can It Tell Us About the Health of the River? pH affects many chemical and biological processes in the water, such as the availability and toxicity of nutrients, metals, and other important compounds. The largest variety of aquatic animals prefer a range of 6.5-8.0. pH outside of this range reduces the diversity in the stream.

D. Total Alkalinity:

What Is It? Alkalinity is a measure of the capacity of water to neutralize acids (see pH description). It is due primarily to the presence of bicarbonate, carbonate, and hydroxide ions, with bicarbonate being the major form. Sources of alkalinity include rocks and soils, salts, algal activity, and certain industrial wastewater discharges.

Why Is It A Good Water Quality Indicator? Measuring alkalinity is important to determining a river's ability to neutralize acidic pollution (as measured by pH), from rainfall or wastewater. To effectively neutralize acid, levels should be greater than 20 mg/l.

What Can It Tell Us About the Health of the River? Alkalinity determines the river's ability to neutralize acids from rainfall or wastewater. If the river is unable to neutralize acid inputs, the pH of the river may change and eliminate certain aquatic life.

Extension Activities

Extension Activities are Global Thinking lessons developed by teachers that you might want to consider as alternative activities for your students. In some cases, the lessons can be accomplished within your class to enrich your students' knowledge of global thinking. In other cases, your students might want to invite other classes to join with them to accomplish the activity.

Contents

An Invitation

The Global Thinking Project invites teachers to submit activities for possible publication in the next edition of Global Thinking. The activities should be written using the format shown in all the Global Thinking activities. Please submit one copy of the activity, and a computer disc in either DOS or Macintosh format or send an email copy of the activity to jhassard@igc.apc.org, jweis@igc.apc.or or mstjrh@gsusgi2.gsu.edu. Please mail to:

Global Thinking Project
c/o Jack Hassard
Department of Middle/Secondary Education and Instructional Technology
Georgia State University
Atlanta, GA 30303
USA

Extension Activity I

Exploring Attitudes Toward Other Nations and Peoples

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The following activity provides an opportunity for student teams to explore, assess, and compare their perceptions of foreign nations and peoples, using one version of a survey instrument developed for a UNESCO-sponsored study in the late 1950's. (Lambert and Klineberg, 1967) As a culminating activity, students compare and contrast their results with those of the original study, as well as with a 1987 follow-up study.

Objectives

• The students will formulate generalizations about students' perceptions of foreign peoples.

• The students will formulate generalizations about influences on students' perceptions of foreign peoples.

Materials

1 copy of Figure 1 per pair or triad
1 copy of Figure 2 per team

Procedure

1. Open the lesson by asking students to name foreign nations that are similar to yours. (Stop after 3 or 4 names.) Continue by asking **how** those nations are similar to yours.

2. Briefly give the background of the UNESCO-sponsored study. (Refrain from reporting the results of the study.)

3. Divide student teams into pairs or triads. Give each pair or triad a copy of the interview questions (see Figure 1). Have each team member interview the other, and record the answers.

4. When students have finished interviewing each other, have them return to their teams to consider the following questions:

1. Which countries were named as most similar to ours?
2. Why were they characterized as similar to ours?
3. From what sources have we acquired our knowledge of these countries?
4. Which countries did we like? Which did we dislike? Which nationalities did w[illegible] ame a nationalities that we would like to have if we had a different nationality? Which nationalities would we not like to have?
5. From what sources have we developed our attitudes about foreign peoples?

5. Provide teams with results from the 1959 and 1987 studies (see Figure 2). Questions to consider in teams and then as a whole class include the following:

1. To what extent to the answers given in 1959 reflect that time period?
2. What are some of the events that determined people's reactions to foreigners in the 1950"s?
3. Based on the 1987 study and your own data, what answers have changed since 1959? Why do you think they have changed?
4. If the same questions are asked 10 years from now, what changes do you predict?
5. What recent developments would tend to change peoples' attitudes toward one another, and in what way?
6. What new sources of knowledge and attitudes are emerging today?

Optional Extensions

1. Have students share interview data with students in other types of communities in their own countries, and with students in other countries, or

2. Have students write their own interview questions to be used to interview their parents, or students at a different grade level, in another community in their own country, or in another country. Report results in the gtp.earthconf.

Questions to consider might include the following:

1. What answers are similar to yours? What answers are different?

2. What generalizations can be drawn about (a) people's knowledge of other people, (b) people's attitudes toward other people, (c) differences in knowledge and attitudes that seem to correlate with age, (d) the different uses made of sources of information about the world.

Figure 1: Interview Questions (a version of the UNESCO-sponsored survey)

1. Are there any other people from other countries who are <u>like</u> you or are <u>similar</u> to you?

   In what ways are [the people named above] like you?
   What else do you know about them?
   Do you like them?
   Why do you say that?
   How do you know about them?

2. Are there other people who are <u>like</u> you?
   (continue with the questions given above)

3. Are there other people from other countries who are <u>not like</u> you or who are <u>different</u> from you?

   In what ways are [the people named above] not like you?
   What else do you know about them?
   Do you like them?
   Why do you say that?
   How do you know about them?

4. Are there other people who are <u>not like</u> you?
   (continue with the questions given above)

5. Now ask the same questions about any nationality or nationalities in which you might be interested.

6. If you were not [your nationality], what nationality would you most like to be?

7. If you were not [your nationality], what nationality would you least like to be?

Figure 2: Background on UNSECO survey, and 1987 follow-up.

In the late 1950's, a UNESCO-sponsored survey was made of 3,000 children in 13 ethnic groups in 11 nations around the world to examine their views of foreigners. Data from the interviews, conducted in 45-minute sessions, were analyzed by Wallace E. Lambert and Otto Klineberg and published in their 1967 work, *Children's Views of Foreign Peoples. A Cross National Study* (New York: Appleton-Century-Crofts).

Children in the U.S. (white and Black), Canada (English-speaking and French-speaking), Turkey, Lebanon, Japan, West Germany, England, France, South Africa (white and Black), Lebanon, Italy and Israel, ages 6,10, and 14, were asked their opinions about foreigners, the source of their opinions, which foreign people were most like themselves, and which were most unlike themselves. In addition to any countries they might have named spontaneously, the children were asked specifically about seven reference peoples: Americans, Brazilians, Chinese, Germans, Indians (from India), Blacks from Africa, and Russians.

American children were found to have positive attitudes toward foreigners. They seemed to become increasingly positive between the ages of 6 and 10, and more negative between the ages of 10 and 14, but they still had positive attitudes at age 14. American children viewed their country as "wealthy and free," they found it difficult to name another nationality "like" themselves, and less difficult to name another nationality "unlike" themselves. They named British, Canadian, French, Italian, and German as nationalities similar to Americans, and African, Chinese, Japanese, and Russian as nationalities that are dissimilar. Older children increasingly named the British a as similar and the Russians as a dissimilar nationality. American children were more negative toward Russians than toward any other group, though more than half of the American children even at age 14 were prepared to view Russians as "friendly" rather than "unfriendly."

As part of research project in 1987, McAlvin adapted the questions from the Lambert and Klineberg study and used them to examine the opinions of students (ages 14 and 15) in a public high school in a predominantly middle class section of suburban Atlanta. Fourteen students were randomly selected from the 96 students in their age group who had been part of the larger study. The following is a summary of the opinions expressed by this group of students:

1. Students did not feel responsible for knowing about any country they had not studied in school.
2. The British were viewed as most similar to people in the United States, and British was the nationality these students would like to have if they were not Americans.
3. Africans and Soviets were viewed as people the most different from people in the United States.
4. Students tended to base their evaluations on their perceptions of the degree of political freedom, civil rights protection, and material well-being enjoyed by the people of a given country.
5. Unlike children in the 1959 survey, these students found Japan to be "like" the United States.
6. Most the students (13 of the 14) named "Soviet" as a nationality they would not like to have. They cited governmental repression, enmity between our two nations, Soviet military power, the difficulties encountered by consumers in a planned economy, and mobilization of opinion ("The way they talk about us, and the way we talk about them.") as reasons for their evaluation.

Extension Activity 2

Imagining My Future

In an introductory activity to the Student Study Guide for *Biological Science, An Ecological Approach* (1987. Dubuque, IA: Kendall/Hunt Publishing Company, pp. 1,2), students are invited to predict what their futures will be like. We include the questions from this activity here, to encourage your students to begin to examine the implications of the content they will study as part of the Global Thinking Project on their future lives. These questions also provide an opportunity for students to conduct cross-cultural research on their perceptions of the future.

Objectives

• The students will make predictions about what they think their future lives will be like.

Materials

Figure 8 (1 copy per student)

Procedure

1. Hand out the questions on Figure 8, and ask students to complete them without consulting one another.

2. When students have finished, have them discuss and compile their responses in teams on chart paper, and post the results around the room.

3. After students have had a chance to read other groups' responses, discuss their predictions as a group. Questions to consider might include the following:

- Are there any recurring themes or trends?
- Are the outlooks generally positive or negative?
- What do they think are some of the influences on their perceptions of the future?
- Are there aspects of their predictions that they can personally influence? Which, if any, are out of their control?

4. Close the discussion by previewing the upcoming projects in the Global Thinking Project. Emphasize that these have been designed to empower students to develop solutions to global ecological problems, in cooperation with students in other communities all over the Earth.

Optional Extensions

1. Compare your class' responses to the questionnaire with students in other communities. What similarities and differences are there?

2. Draw a team mural depicting how you think your community will look when you are your parent's age.

Figure 8: Predicting Your Future[1]

The purpose of this activity is to encourage you to imagine what you think your life will be like when you are the age your parents are now. Based on what you know and what you can guess, answer the questions below. When you finish, you will share your predictions with other members of your team.

1. Where do you think you will live?
2. Will you live in a city or a rural area?
3. Will you be married?
4. Will you have children? How many?
5. How will you care for your children?
6. Will your parents live with you?
7. What sorts of food will you eat? Where will they come from? Will you grow any of your own food?
8. What sort of work will you do? Where will you do it?
9. What sort of exercise will you get? Where will you go for it?
10. How healthy do you expect to be?
11. What will your surroundings be like? Crowded and polluted, or spacious and clean?
12. What other predictions can you make?

[1] Adapted from *Biological Science Curriculum Study, Student Study Guide for Biological Science, an Ecological Approach.* 1987. (Dubuque, IA: Kendall/Hunt Publishing Company) pp. 1,2

Water, Water Everywhere

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This activity introduces the students to the importance of water in their lives and some of the effects of water pollution. The activity's structure is a form of cooperative learning developed by a group of teachers in St. Petersburg. The activities are designed to be completed by teams of 4 students.

Objectives

• Students will explore some of the fundamental properties of water.

Materials (per team)

One copy of Attachment 1: Instructions for Block 1
One copy of Attachment 3: Instructions for Block 2
one set of cards A-D, for Blocks 1 and 2 (see Attachments 2 and 4)
3 glasses
samples of petroleum products

[if optional extension is to be pursued, one set of cards A-D for Block 3 (Attachment 5) and the following:

copper sulfate crystals
vegetable oil
sugar
thermometer
three capillary tubes (different diameters)]

Procedure

This activity consists of two "blocks" (see Figure 1). Each "block" consists of 4 different cards (one per team member). Each card contains 3 different pieces of information.

Completion of a "block" consists of (1) individual work with one card, and (2) participation in a team activity involving all 4 cards.

1. Distribute Instructions for Block 1 (Attachment 1) and one set of cards A-D for Block 1 (Attachment 2) to each team. Allow time for team members to study the cards and share the information on them with their teammates.

2. Invite representatives from each team to report on their teams' discussions to the class.

3. Distribute Instructions for Block 2 (Attachment 3) and one set of cards A-D for Block 2 (Attachment 4). Allow time for team members to study the cards, and share the information them with their teammates.

4. Invite representatives from each team to report on their teams' discussions.

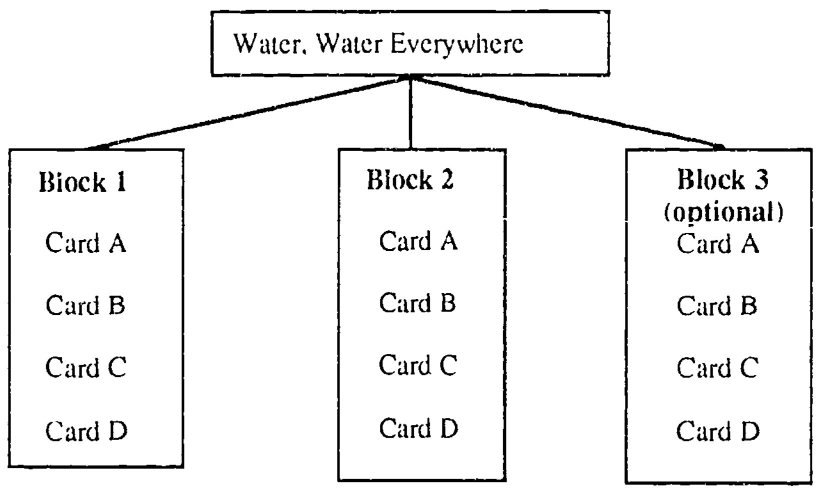


Figure 1. Organization of "Content Blocks" in Water, Water Everywhere

Optional Extension

Attachment 5 contains a third set of activity cards (Block 3, A-D) which address some of the special chemical properties of water. To use these cards, follow the same procedure as you did for Block 1. There are no follow-up questions at the end Block 3.

Attachment I: Instructions for Block I

Individual work with the cards:

1. Read the first part of the card. Think about how to explain its contents to your teammates. Use a reference book, if necessary.

2. Perform task number 2 on your card. Use a reference book to look up any unfamiliar terms.

3. Read the third part of your card. It contains some practical advice or questions about the ecological situation in your city or your state.

Team work with the cards:

1. Each team member in turn should follow these steps:

   a. Explain the first part of your card to all members of your group. Use illustrations if necessary.

   b. Discuss your answer to task number 2. If experiments were required, show them to your teammates, and discuss the results.

   c. Explain the third part of your card to your teammates, and give an example.

2. After each team member has reported on his/her card, discuss the following questions in your team. Prepare one team member to report on this subject.

   What is the role of water in the lives of human beings?
   What are the important life functions of water?
   How much water is needed by a human being in 24 hours?

Attachment 2: Cards A-D for Block 1

Block 1
Card A

1. Human beings consist primarily of water. Various body tissues contain different proportions of water. The total water content in the body of a young person amounts to 60-70 percent of his/her total body weight.

Water makes cells elastic. All biochemical processes occurring in the body occur in aqueous solution. Bodyfluids also cushion organs such the brain, and help maintain organs in their proper positions in space.

When fasting, a human being could lose all of his/her fat and almost 50 percent of his/her protein and still survive; a loss of 10 percent of his/her water is lethal.

2. What is the water weight in your body? How much water can you lose before endangering your life?

3. Water lost due to exertion or illness must be replenished. Remember that water loss also involves loss of dissolved salts. Therefore, it is important to replace lost body fluids with salt solutions rather than pure water.

Block 1
Card B

1. The daily water requirement of an adult is 40 grams per kilogram of body weight.

2. Calculate your daily water requirement. In what ways is water normally lost by the body? Try to explain why a human being cannot live without water for more than a few days.

3. Dietitians recommend that we drink at least eight glasses of water each day.

Attachment 2 (cont.)

Block 1
Card C

1. Evaporating water facilitates body cooling. Since the heat of vaporization of water is high, evaporating water molecules remove a large amount of thermal energy. Many living organisms exploit this feature to cool their bodies.

Many reactions that occur in the body are exothermic (they give off heat). Why are no "hot points" formed in the body?

Why do you sweat when it is hot outside?

2. Why does your skin feel cool when alcohol is rubbed on the skin? If you were trying to reduce a fever, would it be more effective to use compresses of cold water or alcohol? Why?

Block 1
Card D

1. One of the hypotheses explaining the origin of life suggests the life originated in the environment of the primordial ocean. Blood serum contains the same chemical elements, compounds and ions as those found in sea water:

ions, compounds	blood serum	sea water
Na+	39.0	30.0
Mg2+	0.5	3.8
Ca	1.0	1.8
K+	2.6	1.8
Ce-	45.0	55.2
CO2	11.0	0.5
other elements	0.9	7.0

2. Why don't blood cells break if you drink a lot of water?

Why don't blood cells shrink if you eat a lot of salty food?

3. Sodium and potassium ions are extremely important for human life. They are important for the normal functioning of nervous and muscle tissue. People with muscle cramps are sometimes encouraged to eat bananas, which are high in potassium.

Nutrient substances such as mineral salts enter your body with food, and are absorbed into the blood and lymph through the large intestine. Blood carries nutrient substances to the body cells. The stability of the internal environment is maintained by the blood and internal organs.

Attachment 3: Instructions for Block 2

1. Read the first part of your card. Think about how to explain it to a teammate.

2. Perform task 2 on your card.

3. Read the third part of your card. It contains some practical advice or questions about ecological situations in your city or in your state.

4. Find one teammate. Teach your teammate the information in the first part of your card. Answer any questions.

5. Listen to the first part of your partner's card, and ask questions.

6. Exchange cards, and perform task 2 on each other's cards. Discuss the two tasks and your results with your partner.

7. Teach each other the information in the third parts of your respective cards.

8. Find another member of your team, and proceed as before. Your work is finished when you have completed steps 4-7 with each member of your team.

9. After your team has completed its work with the cards, discuss the following questions. Prepare one team member to report on you discussions to the class.

> What kinds of water pollutionhave you learned about?
> Can you think of other examples of how humans pollute waters.
> How can polluted bodies of water affect the surrounding areas?
> How can bodies of water be protected from pollution, while allowing for technological development?

Attachment 4: Cards A-D for Block 3

Block 2
Card A

1. Phosphorus is an element that encourages plant growth. Phosphorus-containing fertilizers greatly increase crop yield. Lakes and rivers get their phosphorus from rocks, and their phosphorus levels are usually low. Lakes are polluted by phosphorus by means of waste water runoff which is rich in phosphorus-containing fertilizers and detergents.

2. What do you think would be the effect of phosphorus pollution on a lake? Could trout live in such a lake? (Trout prefer clean water rich in oxygen.)

3. The processes occurring in lakes polluted by phosphorus cannot be stopped, but they can be slowed. If the waste flow is stopped, algae feeding on the pollutants will die and sink to the lake bottom. Slowly, the lake will clear. What do you know about the lakes in the vicinity of your town? Do trout live in them? Do they contain surplus phosphorus?

Block 2
Card B

1. Acid rain is a very serious problem. Acid rains are formed when sulfur-containing compounds (mainly sulfur dioxide) discharged into the atmosphere by industrial plants and automobiles react with water vapor in the air to form acids. These acids precipitate to the Earth's surface as rain and snow. Acid rain destroys paint and stone, as well as damaging the environment of lakes and ponds. The water of various bodies of water may become so acidic that fish die.

2. Write a chemical equation for the formation of acid rain.

3. A 1979 survey carried out in the Adirondack Mountains of New York State indicated that all fish had died in 264 lakes in the area due to acid rain. What sort of effects do you think this had on the local economy?

Attachment 2 (cont.)

Block 2
Card C

1. Many toxic substances are known to be dangerous for aquatic organisms. Most of them are absorbed and accumulated by these organisms. Fish living in a lake poisoned by chlorohydrocarbons and mercury will store these chemicals in their bodies, thus becoming poisonous for people to eat. Plastic and aluminum debris also pose dangers for aquatic animals and humans.

2. Given time, it is possible that marine microorganisms can decompose plastic. Since plastic is similar in its composition to nutrients, what would be the result of this process? Would this water be drinkable?

3. Mariners report that the Atlantic surface waters from the Caribbean Sea to the coasts of Europe are littered with plastic debris. What would be your policy with regard to plastic and aluminum. How would you describe the bodies of water near where you live. Are they polluted with plastic and metals?

Block 2
Card D

1. Petroleum products may greatly pollute the water environment. Oil is less dense than water; it is not water soluble. It has less surface tension than water, which is why it spreads on the surface of water forming oil slicks that cannot be penetrated by oxygen. Petroleum products pollute coastal zones and beaches, endanger the existence of living organisms, and kill birds living in the coastal zone. Oil spills are often the result of tanker wrecks, oil exploitation in the off-shore zone, and ship diesel pollution.

2. Petroleum products are refined to get kerosene, heavy oils, gasoline, lubricants, and other products. You should check their behavior in water. It is similar to that of petroleum. Fill three glasses with water, and then add a few drops of kerosene, gasoline, or heavy oil to each. What changes do you see in the different glasses?

3. Are the bodies of water near where you live polluted by petroleum products? Can you identify any of the sources of this pollution?

Attachment 5: Cards A-D for Block 3 (optional extension)

Block 3
Card A

1. The unique properties of water are determined by its chemical structure. The oxygen atom is covalently bound to two hydrogen atoms. The molecule is bent, with an oxygen atom at its apex, and two hydrogen atoms at the sides. Since oxygen attracts electrons more strongly, the oxygen atom has a partial negative charge, while the hydrogen atoms have partial positive charges. The oxygen atom of one molecule is attracted to the hydrogen atom of another molecule, forming a hydrogen bond. Each water molecule may become hydrogen bonded to four other water molecules.

2. For a molecule of its small size, water has a relatively high boiling point. Can you explain why, taking into account its molecular structure?

3. Most of the solar energy absorbed by the Earth's surface is lost due to evaporation. Solar energy absorbed by the vaporization of water is released again when vapor condenses into clouds. This energy becomes thermal energy and worms the air. Atmospheric moisture can be compared with a warm blanket covering planet Earth.

Block 3
Card B

1. The water molecule's polarity is responsible for its most interesting property: its ability to dissolve various compounds. The most soluble substances are ionic compounds, e.g. salts and other polar compounds. The process of solution is accompanied by heat absorption and release. Many aqueous ions are colored.

Non-polar substances dissolve poorly in water. In these cases, an interface is formed between water and the non-polar compound. These interfaces are very important in living organisms, since it is on such interfaces that many chemical reactions occur.

2. Fill three small glasses with water, and measure the water temperature. Add some copper sulfate crystals to the first glass, and stir carefully. Note whether the compound dissolves, and whether there is a temperature change. Repeat with vegetable oil and sugar. In which glass did you produce aqueous ions? Why do you suppose it is recommended that salad oil be poured on a salad immediately before serving?

3. Mineral water is healthy. It contains a lot of dissolved salts and other compounds vital for living organisms. Are there mineral spas or springs in your state? Where? Have you ever visited one or tasted the water?

Block 3
Card C

1. Water molecules are subject to cohesive forces, which attract them to one another. The water molecules at the surface of water are attracted down into the water. This results in a sort of "skin" on the water's surface called a surface tension film. (Try floating a needle on the surface of a glass of water, and you will be able to see this "skin.") Water also adheres to other materials and "wets" them. "Wetting" and surface tension explain the ability of water to move into small pores and cracks, even when opposed by gravity.

2. Place three capillary tubes of different diameters vertically in a glass of water. In which tube is the water level highest? Why?

Why does the volume of your hair seem to decrease when it is wet?

3. Various additives to water can decrease its surface tension. Float a needle on top of a glass of water. Carefully add a few drops of detergent near the edge. What happened?

Block 3
Card D

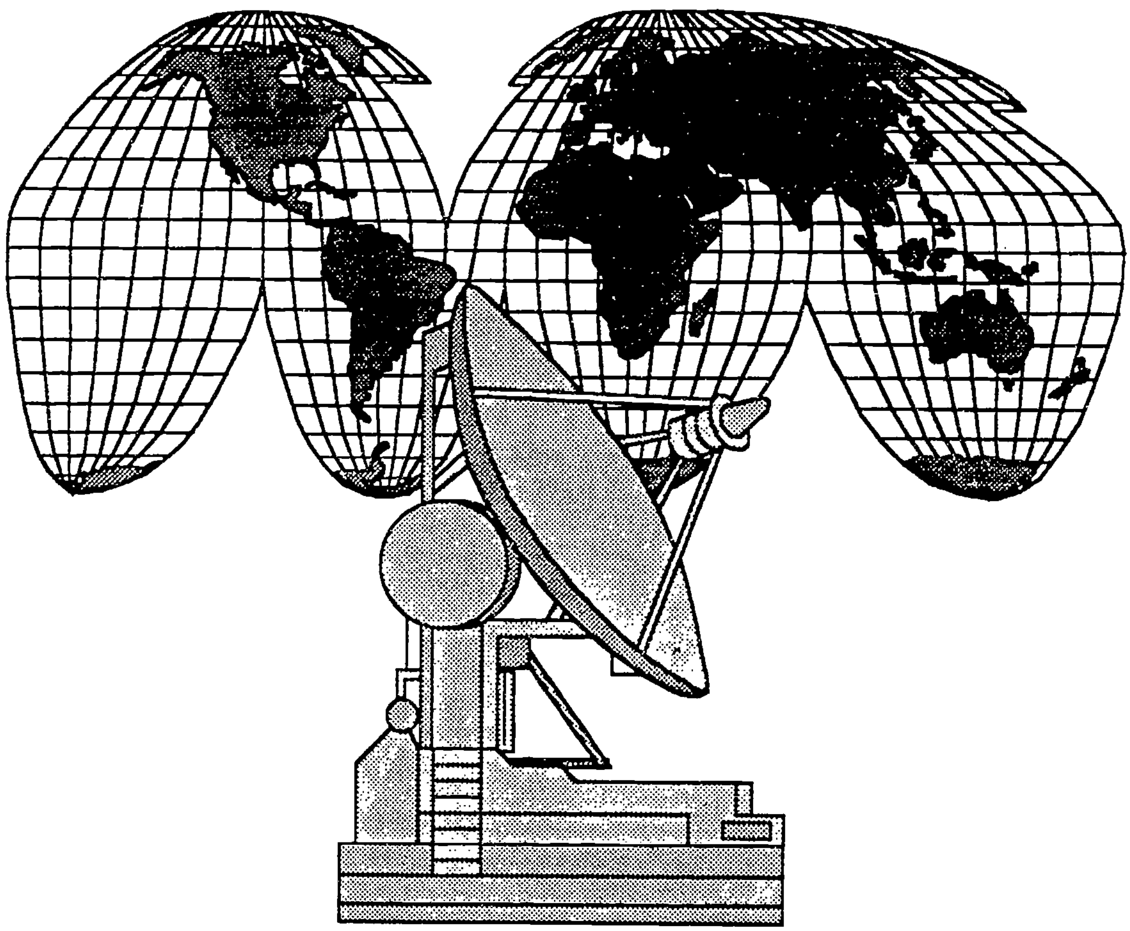
1. Water is a chemically active substance. It participates in millions of chemical processes occurring in the natural environment. For example, rain water containing dissolved carbon dioxide reacts with limestone (calcium carbonate) to produce soluble calcium bicarbonate. When this solution comes to the surface and evaporates, calcium carbonate precipitates again, forming beautiful cave formations such as stalactites.

2. If calcium bicarbonate and magnesium are present in water, the water is said to be "hard". What are some disadvantages of having "hard" water in your home? Find out how water "softeners" work.

3. Stalactites are among the most beautiful of tourist attractions. Are there caves in your area which contain interesting limestone formations? Have you ever visited them?

Global Thinking Notes

Student Journal and Log



Name______________________School__________________

Global Community____________Team Members__________________

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