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Teaching Global Issues Through Mathematics

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One significant way to show that mathematics is a humanistic discipline is to give a course that helps provide understanding of the many critical problems that face the world today.

Teaching global issues through mathematics has several important advantages:

1) Students' eternal questions about mathematics: "Why do I have to learn this?" and "What relevance does it have?" are answered. Students' motivation toward mathematics is greatly increased, as they see how mathematics can provide knowledge and understanding of current critical issues.

2) Coherence is provided to a mathematics course by focusing all the mathematics on global issues.

3) Students are not lulled by vague generalities; they are able to integrate hard data. For example, students do not get only a general idea that population has been increasing rapidly; by plotting a graph of world population growth versus time and solving related mathematical problems, students obtain a firmer understanding of the nature of population growth and related terms such as doubling time and exponential growth. By solving a problem related to the fact that in 1986, the world spent $900 billion on the military, an amount equal to the income of the poorer half of the world's people, students get valuable insight into the huge sums spent for the military, as well as the tremendous poverty in much of the world.

4) Students become aware that their studies can provide the valuable background information necessary for them to play an active role in helping to solve world problems.

5) The relationships between variables such as population, pollution, hunger, energy, waste, and the arms race are clearly shown. Stress can be placed on the important ecological principle that everything is connected to everything else and hence that you can't do one thing without affecting many other things.

A course relating mathematics to global issues can be valuable in several situations:

1) for liberal arts students, who need some mathematics to meet graduation requirements. Currently these students generally take a smattering of subjects such as set theory, logic, math history, number theory, and introduction to statistics, with no coherence and little relationship to current issues. A math course related to global problems can be related to material they're learning in their classes in such subjects as history, economics, and political science.

2) as an elective to provide useful background information for careers of students in such fields as ecology, business, technology, engineering, and education.

3) as an enrichment course for high school students who wish additional math, but don't need subjects like calculus or computers for their career goals.

During the past 14 years I have related mathematics and global issues in a course "Mathematics and the Environment" at the College of Staten Island. It is a three credit, elective course, designed primarily for liberal arts students. After several years of using a wide variety of background materials, many of which are discussed later, I wrote a text, Mathematics and Global Survival. (See annotated references and sources.)

Some examples of mathematics problems that have been used in the course are:

1) It has been estimated that the average American has 50 times the impact on the environment (in terms of resource consumption and pollution) as does a person in an underdeveloped country. How many people in these countries have the same impact as 246 million Americans (1988 population)?

2) From 1946 to 1968, consumption of plastics per person increased by 1024 percent. For every pound of plastics used in 1946, how many were used in 1968? Repeat for synthetic fibers (1792% increase),nitrogen fertilizer (534% increase), synthetic organic chemicals (495% increase), and aluminum (317% increase).

3) In 1988, Nicaragua's population was doubling every 20 years. At that rate, how many people would there be in Nicaragua in 100 years, for every one there today?

4) Draw a circle diagram showing the population for the major regions of the world. (This utilizes data from the Population Reference Bureau's 1988 World Population Data Sheet).

Other kinds of mathematics problems which can be presented using information on the population Data Sheet involve computing histograms for such things as birth rates, physical quality of life indices, etc., and investigation correlations between such variables as birth rates and per capita GNPs.

5) Plot a graph of total production of electrical energy in the U.S. versus time, using the data given below.

See Table at end

This graph shows the great increase in electrical energy production (it doubled about every 10 years, until recently) and helps students understand the many recent problems related to energy.

6) The average diet in the U.S. requires about 3.5 acres per person. The diet of an average person in the underdeveloped world requires about 1/5th of an acre. What is the ratio of acres required by a person in an underdeveloped country? (Note: In 1978, there was about one arable acre per person in the world, and population is growing rapidly).

If it is not possible or desirable to give a complete course relating mathematics and global issues, a mini-course could be given. For example, there could be a variety of math problems related to one issue such as energy, the arms race, population, or hunger. Or, if it were necessary to teach one math topic such as computing percentages, drawing graphs, or working with sequences, a variety of global issues and problems could be covered related to the appropriate mathematics topic.

To add to class interest, news and magazine articles related to the course can be discussed. There are several articles daily related to some aspect of the course. This helps show the relevance of the mathematics covered to everyday events.

The course can also be related to events such as Sun day, food day, and U.N. conferences related to population, hunger, environment, water resources, habitat, decertification, and disarmament. From time to time, films and slide presentations can be shown to improve student awareness and understanding.

Instead of a final examination, students can report to the class on some global issue they have researched, using mathematical concepts covered in the course. These reports enable the class to get an introduction to a wide variety of important issues, not otherwise covered, or to gain more knowledge and understanding of topics that were covered. Student reports have been on topics such as solar energy, noise pollution, the greenhouse effect, ozone depletion, destruction of tropical rain forests, pesticides, world hunger, and surveys of student opinion on various issues.

Through the course, students learn of the relevance of mathematics to global problems. They become very aware of global issues and the need for fundamental changes to avoid future crises. Many students have stated that their personal habits were changed through participation in the course, and they often spoke to friends and relatives about the need to solve global problems.

In closing, I feel strongly that this type of course can make major contributions to mathematics education and global awareness. I hope that similar courses will soon be offered at many other colleges, high schools, and perhaps even elementary schools.

A discussion of sources for further mathematical problems follows:

1. The population Reference Bureau, Inc., (777 14th St. NW, Suite 800, Washington, D.C. 20005) is an excellent source for information related to population. We have already referred to their annual World Population Data Sheet which gives a wealth of information on the world's regions and countries. They also have a "Population Handbook" which has a comprehensive summary of demographic techniques with many sample problems related to the World Population data sheets. Other valuable mate-

rial includes population sheets, teaching modules, and bulletins. Two bulletins with especially useful information (statistics, graphs and charts) on population are "Man's Population Predicament," Vol. 27, No. 2, 1971, and "Our Population Predicament: A New Look," Vol. 34, No. 5, Dec., 1979.

Special data sheets and other background material with many graphs, charts, and data were produced related to the International Year of the Child, in 1979, and International Women's Year, in 1980.

2. Mathematics and Global Survival, by Richard H. Schwartz (Ginn Press, 160 Gould Street, Needham Heights, MA 02194-2310; 1-800-428-GINN).

A 290 page text book with a wide variety of mathematics problems related to pollution, hunger, resource scarcity, energy, the arms race, and rapid population growth.

3. The Limits to Growth, by D. Meadows, et al, New York, Signet, 1972.

While somewhat dated and controversial this book uses several concepts related to mathematics, including exponential growth, mathematical models, feedback loops, quantification of variables, and many charts and graphs. It gives students valuable practice at interpreting material with both mathematical and global applications, while providing a warning about the results of continued unrestrained growth.

4. The Complete Ecology Factbook, J. Deedy and P. Nobile, editors, Garden City, N.Y., Doubleday, 1972.

Much ecological data, graphs, and charts. Excellent background materials for the construction of mathematical problems.

5. World Military and Social Expenditures, 1987-88, by Ruth L. Sivard, World Priorities Publications, Box 25140, Washington, D.C. 20007

An Excellent annual publication which has much information on arms expenditures and the impact on social issues. Many charts, tables, and graphs are provided.

6. The United States and World Development Agenda, 1985-86, by John W. Sewell, et al and the Staff of the Overseas Development Council, New Brunswick, N.J.: Transaction Books, 1985.

Much information is presented in the form of tables, charts, and graphs, related to developmental issues such as trade, the arms race, population growth, education, health, and many more.

7. The Mathematics of the Energy Crises, R. Gagliardi, Westmont, New Jersey, Intergalactic Publishing Co., 1977.

Over 130 mathematical problems related to energy for secondary students.

8. Mathematics in Energy, National Science Teachers Association (John M. Fowler, Project Director), Nov. 1978 (can be obtained from the U.S. Department of Energy Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee, 37830)

Energy problems involving fractions, decimals, percents, and graphs. Also has energy activities involving mathematics problems and a summary of energy facts.

9. Energy-Environment Source Book, John M. Fowler, National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, D.C. 20009, 1975.

A very comprehensive discussion of all aspects of energy extraction, conversion, and use, and related environmental problems. Many graphs, tables, and charts provide useful information for mathematics problems.

10. Mathematics for Ecologists, I. Chaston, London, Butterworth & Co., 1971.

An introduction to basic principles of advanced mathematics (calculus and linear algebra) applied to ecological problems.

YEAR	ELECTRICAL ENERGY (trillion Kilowatt hours)
1902	6
1912	25
1920	57
1930	114
1940	180
1950	389
1960	844
1970	1640
1975	2003
1980	2286
1986	2489