Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1998 Volume VII: The Population Explosion

Population Needs vs. Population Deeds

Curriculum Unit 98.07.04
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INTRODUCTION

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@Text:This unit is intended to make the student aware of the seriousness of the "population explosion" and to satisfy the National Science Education Standards on Populations and the abilities of technology to identify and implement solutions to the various population problems.

A good start for this unit on population can be found in "Populations" by the Globe Book Company. It starts off by using the example of giving a party for 15 friends. However, each person decided to bring another person with them making a total of 30 people in attendance. This caused the party to be "overpopulated" for the amount of refreshments and space. Everyone leaves the party hungry and there was not enough room to socialize and dance. As most students have gone to parties that have been well organized as well as those that have been "crashed," they can begin to relate to the problem of overpopulation. The teacher can stress that this is just an example of overpopulation on a small basis but ask them to think about this form of living worldwide everyday.

Ask them to come up with some solutions for solving the situation at the party. Make it clear to them that the party situation can be remedied more easily than the worldwide population problem. Unlike the party, we live in a "closed" system and cannot send out for more resources nor can we kick people, once born, off our planet. Therefore, we must look at the situation and begin to take proper steps to save our world from unnecessary disaster.

A good demonstration to show a "closed" system is to use a flask, balloon, hot plate and a balance. Place the balloon over the opening of the flask and measure the combined mass. Place them on the hot plate and heat the flask. The balloon will expand as the air inside is warmed. Remove the flask and balloon from the hot plate

(do not touch with your bare hands) and measure the combined mass. Ask students why there was no appreciable change in the mass before and after heating. They will tell you that no air could get in or out of the container. This should help them understand what we mean by a closed system.

Man has the greatest impact on our "Closed System," the Earth. Technology, use of natural resources and standard of living contribute to population attitudes such as birth rate, emigration and immigration to name a few.

To help the student understand the complexity and seriousness of solving population problems, we may use CPUP Kits at various stages of the unit. These are field-tested, age appropriate activity centered kits available to New Haven teachers of science. These kits allow the student to investigate societal issues that are happening in the real world today and hopefully make many of the concepts on population more understandable by providing an opportunity to perform scientific investigations and make decisions based on their data. These investigations make them realize that science and technology have certain limitations.

A brief explanation will be given about these kits and suggestions will be made where these kits may be used.

POPULATIONS

A population is defined as a group of organisms that breed with one another and live in the same space. We know that no population stays the same in size but it is important to study the trends in order to plan for the future. We know that a population has certain needs. It appears that the population density, the number of individuals in a given space, is more important for population survival than just the total number of individuals. The higher the population density, the more competition for resources comes into play.

It has been estimated that the world population is increasing by over 80 million each year and will continue to grow at this rate for the next 30 years. If this projection is correct, we will have a global population of 8.5 billion by the year 2030. What will happen to our environment and quality of life?

This is a good time to introduce the Human Population Growth chart. Have the student's brainstorm on reason why such a jump in human population is a relatively new phenomenon.

From: World Population: Toward the Next Century, Washington, DC: Population

Reference Bureau. Copyright 1994. Reprinted with permission.

The brainstorming can bring into play that in earlier times there were many more life hazards such as hunger, accidents and disease to contend with than we now experience. These hazards in earlier times plus a more migratory existence tended to lead to a shorter life.

The importance of agriculture, which began about 10,000 to 12,000 years ago, is also an important concept the student can discuss. Food became more plentiful and available, The nomadic type of life was given up for the farming of the land. Having a more stable food supply and a settled existence not only helped to lower the mortality rate but is believed to be one of the causes for an increased birth rate. Eventually the population increase caused a stain on the available resources and we were right back where we started with a scarcity of food.

The Industrial Revolution again caused a major life style change by using machine power instead of manpower. The introduction of modern farm machinery meant that fewer people were needed to produce food. People began to migrate to where the jobs were more plentiful. Large families were more an expense than help and slowly the birth rate began to decline. This population pattern is known as "demographic transition. This consists of three stages:

a. Initial Period - High birth rate and high death rate.(Before Industrial Revolution)
b. Second Stage - High birth rates and low death rates.(After Industrial Revolution)
c. Third Stage - Low birth rate and low death rate.(Economic growth and education)

The industrialized countries that have gone through these stages of development are called developed countries.

Health research has played and continues to play a major role with population. Educating the population about the importance of cleanliness and sanitation helped increase longevity and decrease infant mortality by eliminating exposure to certain disease carrying organisms. Before the Industrial Revolution people were unaware of relationship between bacteria and disease. The invention of the microscope allowed the discovery of these tiny organisms, which eventually led to the discovery of antibiotics and vaccines.

The increase of population did not always increase at a steady rate. The plague, which eliminated about 1/3 of Europe's population, is the most noticeable event on the "World Population Growth Through History" chart. Exploitation of resources causing social and economic problems, hunger, migration and war are causes for variations in population growth. We say that the "threshold" is reached when these types of actions take place.

If you desire to have your students do a "hands-on" activity to become more familiar with the term "threshold," this might be the time to introduce the CEPUP MODULE "Determining Threshold Limits."

NEEDS AND DEEDS The unit now begins to discuss what the human population needs to survive and how some of our deeds will help or hinder survival. As we discuss the various needs and deeds, we must keep in mind that there are a variety ways to look at causes and solutions to environmental problems. Most of us have experienced situations where we wanted to do the "right thing" except it would not be to our advantage and so we rationalized why we did not do the "right thing." Environmental problems are faced with the same dilemmas and an open mind is necessary to properly evaluate each situation. .

FOOD

All living things need food. We, as humans, have an advantage over other forms of life by being able to grow and enrich our food. However, underdeveloped countries do not have the advantages of refrigeration, good soil, adequate water, food packaging and food storage as are available to the industrialized nations. These factors contribute to a big gap in the quality and the amount of food available in these underdeveloped

countries.

As stated above, industrialized nations use technology to increase food production, package food for longer life, and encourage specialization by large commercial farms. Large-scale farming is taking a drain on our resources by having to use various methods to preserve the food and keep it as fresh as possible. One method of preservation is packaging. The negative consequence is that packaging consumes about ½ the paper produced and ¼ of the plastics for this process. The problem of waste disposal from the packaging of the food also enters the picture. The removal of these waste products adds to the pollution problem.

The human population impacts the environment by demands for more food. This demand is met in a variety of ways. One method is to clear more land for growing food. It is estimated that about 400 billion acres of forest are destroyed each year. True not all this land is used for growing food for human consumption but other species use this land for food and shelter. Will this destruction eventually cause weather and climate changes that will affect food production for the human race?

We use about 300 billion pounds of fertilizer each year to increase food production and prevent the degradation of the land. The use of the land for mono cropping relies on the fertilization to replace the nutrients used by the plants. This type of farming is profitable because they are only dealing with one type of food source. However, some of the farms are now rotating crops to become less dependent on fertilization using a crop that will help replenish the lost nutrients.

Another serious but necessary problem for farmers is the use of pesticides. It is estimated that about 6 billion pounds of fertilizer are used each year to protect their crops. The down side is that about 2 million people suffer from cancer caused by contaminated food and water. Does the need for food out weigh the deed for pesticides?

Irrigation is another way to increase food productivity. Bringing water to places that otherwise would be unable to support the growth of crops can also have a down side. One factor is that the irrigation process is using the groundwater faster than the water can be replaced. The other factor is that water carries the dissolved salts to the plants it irrigates. Over a period of time, the water evaporates leaving the salts behind that eventually will kill the crops.

Soil is very important for food production. It takes about 10,000 years to build about one foot of soil and only 48 years to destroy this amount. Therefore, it is to our benefit to save the land and use it wisely. We must remember the "Dust Bowl" of the 1930's.

This event happened in the southwestern Great Plains region and lasted approximately ten years. It was caused by the misuse of land and hears of a sustained drought. Because wheat prices were high, farmers plowed up grasslands and planted more wheat. This increase in production would then bring them a larger profit. Year after year they worked the land. The lack of grass to anchor the soil caused the soil to dry up. As the land dried up, the wind caused great clouds of dust and sand to rise and cover everything. Large areas of farmland became useless and people were forced to migrate to other areas, mainly California.

WATER

Clean freshwater is another necessity of the human population. Although ¾ of the earth is covered with water, only a small amount is available as fresh water. The student may be or may become aware of the main way water prepares itself to be used by the human population. This method is called the water cycle. If you have the proper equipment, you can perform or have your students do a distillation investigation.

You will need a flask, colored water solution, heat source, distillation tube and a source of cold running water. Setup your distillation apparatus. Ask the student what they think will happen to the colored water solution. Perform the distillation.

Where and how does this type of activity take place on Earth? The student will probably say this occurs over the oceans continuously with the sun being the main source of energy. Why is the conservation of water important to the population? We live in a closed system and the amount of water on earth has remained constant but the demands have increased.

Water is called the "universal solvent" because it dissolves more things than any other single substance. Technology has come up with ways to make water safe to drink but at the same time, it has caused problems such as high construction and maintenance cost preventing underdeveloped countries to benefit from these advances.

Agriculture uses and wastes more water than any other single activity. Seepage, evaporation and run-off of water accomplish this. Municipalities add to this problem by building sewage treatment plants, dams and thermal pollution from industries.

You might make the student aware that water is not distributed evenly throughout the world. Developing countries are currently experiencing difficulty obtaining safe drinking water because of pollution and the scarcity of water. What are some ways we might help to alleviate this Problem?

The Investigating Groundwater: The Fruitvale Story would be a logical Module to use at this time as more than 1/5 of all Americans are dependent on groundwater that is contaminated by lead, toxic chemicals or fecal bacteria.

Conservation is one way to help reduce our use of freshwater. A fun way to make the student more aware of water usage is to have them do a home survey on how water is used in their home. This can be accomplished by having the student keep a record on the uses and amount of water used in their home. The Water Company can furnish a chart on the approximate amount of water used each time a various household task is performed. After completing this investigation, have the student suggest ways water usage in their home can be reduced.

AIR

Good air quality is another basic need for the human population. When the air quality is less than desirable, health problems increase, plants and animals we use for food may become contaminated and unsafe to consume and the contaminants may combine with water causing damage to our physical environment.

The Population Explosion added to the problem of clean air by encouraging people to move to urban areas where generally more and better paying jobs were available. Not only were more pollutants added to the air from industry but by the automobiles as the workers traveled to and from work.

Polluted air is a way of life for most residents in the large cities of New York, Chicago or Los Angles. The heating and air-conditioning units installed in homes increase energy demands and contribute to the air pollution problem.

Most chemicals eventually find their way into the atmosphere. Initially, these are released in such a small amount that there is not a cause for concern. However, over a period of time, this build up in the atmosphere is believed to pose a risk to the environment and human health. Air pollution is believed to contribute to cardiopulmonary conditions that result to more the 60,000 premature deaths in the United States.

A paper on the pollutant carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide might be a method for the student to do research and writing in science. They might also research the effect of particulates and aerosols play in destroying the atmosphere.

OVERPOPULATION

Every population can reach their limit. This is not due to the availability of space but due to the availability of resources. The amount of resources affects the birth rate, death rate, immigration and emigration.

The formula for population growth is:

Population growth = (births + immigration) - (deaths + emigration)

Human population growth has increased for a variety of reasons. Basically we have developed the ability to survive and live in new habitats, increased the carrying capacity of the environment and removed a series of limiting factors.

Although the birth rate is declining, world population is increasing. This is due to the fact that people are living longer and a factor know as population momentum. What this means is that even though people are having fewer children on the average, there are more people having children to offset the birth rate. We presently are not involved in war and no diseases are devastating the world population. As in the past, people have to migrate to where there are more resources. These migrations may cause hardships on the areas they move into and conflicts may result. No one wants to see conflict and so it is very important that we find ways to stabilize our population and provide resources for all the world community.

Advances in technology can create new problems while solving problems for the Population. Since technology is a human generated action driven by human needs, the right procedures must be followed and tested fully before implementing the new techniques.

The Module Toxic waste: A teaching Simulation could be used at this time.

As stated earlier, resources are the main reasons for movement to and from an area. The greater the population, the greater the drain on our resources both renewable and nonrenewable. The length of time and energy required replenishing the renewable resources and the projected time before nonrenewable resources become depleted determine the need for alternatives.

Employment opportunities still tend to be a leading cause for increased urban population. This urbanization for jobs has created "spin-offs" such as increased pollution, unemployment, disease transmission, poverty and homelessness. Many cities are unable to provide the basic needs for all its populous and so deeds such as crime increase.

The higher the population density, the easier it is to transmit diseases even when adequate medical attention is available. However, most times people in poverty have limited access to health services, is illiterate, malnourished, and unemployed. These factors make it quite evident that the human factor will encourage an unhealthy life style.The human factor states that human condition = resources/population or H = R/P. It is quite evident that an increase in population means less resources for each individual. We can again relate to the "party" in the introduction to better understand this formula.

Another useful formula is used to describe the environmental impact the average U.S. places on the environment. The formula is I =PAT. This formula says that Impact Equals population size times affluence (individual consumption) times Technology and resulting pollution.

It has been calculated that the environmental impact by Americans is about 20 times greater than that of a Costa Rican and 70 times of a Bangladeshi. The U.S. contains about five percent of the world's total population but use 20% of all the metals, 25% of all the fossil fuels and 33% of all paper while producing 72% of the total toxic waste output in the world.

Does this mean we have an overpopulation problem? U.S. population growth is about 1% or roughly 2.7 million people. Of this number, 70% are due to natural increases and 30 % are from immigration. Because of the I = PAT formula, the impact for the 2.6 million U.S. people is equal to 54 million Costa Ricans and 190 million Bangladeshis.

Politically, the U.S. appears to encourage people to have more children. The income tax structure provide greater deductions for larger families and they are trying to give additional tax credits for college tuition which further reinforces this belief.

Technology increased unemployment, lower wages and increased population has caused a 50% increase in people living at the poverty level. In 1995, US workers earning below below-poverty wages reached 30%.

The United States has one of the highest natural population increases for industrialized countries with no relief in sight. Unless changes are made in the way we utilize our natural resources and treat our waste products, our quality of life will continue to decline.

There is a disagreement in the scientific community whether the human population has an upper limit. Some

think that technological advances and improved food production and disease control will keep up with population growth.

Other scientists believe that at some point, the earth will no longer be able to provide enough food for everyone and the overpopulation of humans will also cause other life forms to become extinct.

In every population, there are certain factors that limit the population growth. These are called limiting factors. The two kinds of limiting factors are abiotic - nonliving factors and biotic - living factors. These two factors working together determine the carrying capacity of an ecosystem.

Under ideal conditions, populations increase to their maximum. However, we know that ideal conditions do not exist. Demographers make a population age structure graph to show population trends and use it to help make predictions about future population growth. This graph can show the age, sex and percent that each contributes to the population.

Extinction is a natural process that occurs as conditions on Earth change. Most species that have ever lived are now extinct. Many times the extinction of one organism leads to the evolution or extinction of another. Two types of extinction have and are taking place. One is called "background extinction" where there is a steady rate of species turnover. The larger and more complex organisms tend to have the higher extinction rate. Mass extinction is the result of a catastrophic event that caused large numbers of organisms to become extinct in a relatively short period of time. Five major extinctions have taken place during Earth history. These occurred during the Ordovician, Devonian, Permian, Triassic and Cretaceous times. These mass extinctions and smaller extinctions have had a profound effect on the history and diversity of life. Human activities have changed the present rate of extinction causing more mass extinction. New evidence shows that the change in physical environment is the most important factor with extinction and evolution. Man surely has the means and is diffinetly causing a change in the physical environment.

SUMMARY

Technology has been the primary force in allowing us to better use our resources by extending and applying knowledge that we have gained over time. However, sometimes the consequences out weigh the benefits. As our population continues to expand, we will have many tough decisions to make.

Take notice of the chart and look at the trends up to 1997.

Only time will tell if the trends after 1997 will continue as predicted. But we do know that the earth's natural resources will continue to be depleted and given the present trends, the increase in population will cause a more rapid depletion.

It is therefore important that we begin to diffuse this vary dangerous situation by making informed decisions. We must make sure the benefits out weigh the costs of any change we make to improve our planet. We must be aware of the side effects and trade-off involved with any plan we implement.

After we gather and analyze the information, we must decide what plan of action will be the most logical route to follow. This will probably be the difficult phase as it is hard to persuade people to do what is right thing if it does not give them immediate gratification. It is important that the plan contains activities that an individual

can perform as well as to participate as a group member.

We must continue to research, develop and use new technology to help us survive without going to war over resources.

ANNOTATED TEACHER/STUDENT BIBLIOGRAPHY

ENVIRONMENTAL SCIENCE SERIES - COPYRIGHT 1995

GLOBE FEARON EDUCATIONAL PUBLISHER

240 FRISCH COURT, PARAMUS, NEW JERSEY 07652

CHANGING POPULATIONS:

Provides activities in the form of lab studies, field studies and gives the student an opportunity to "Solve It." This main focus of this text deals with human populations.

WATER AND AIR:

Contains three case studies dealing with water supply, quality, conservation and air pollution issues.

ENERGY:

Reviews how people use energy , renewable and non-renewable energy sources, nuclear energy and suggestions for energy conservation.

LAND USE:

Discusses the various ways land is used and provides interdisciplinary connections.

ECOSYSTEMS:

Deals with human values and how they impact the ecosystem.

SCIENCE, TECHNOLOGY, & SOCIETY SERIES - COPYRIGHT 1993

GLOBE BOOK COMPANY

190 SYLVAN AVENUE

ENGLEWOOD CLIFFS, NEW JERSEY 07632

POPULATIONS:

Deals with the topics of extinction, human populations, health and food resources.

TECHNOLOGY: Contains articles dealing with resources, hazardous substances, space exploration and technology.@$: RESOURCES:

Deals with water, air and land resources.

CPUP MODULES These kits are available: Plastics in Our Lives

Should their town use exclusively plastic bags or paper bags?

a. Decision-making may be based on ideal versus practical criteria.

b. Properties of substances create advantages and disadvantages in their use.

c. Trade-offs are involved in decision-making processes.

d. Energy costs are hidden but an important consideration in product design.

Investigating Chemical Processes: Your Island Factory

Four representative industries - computers, food processing, chemical manufacturing and oil refining - are examined. The student is introduced to chemical reactions and the meaning of products and by-products.

a. What factors must be taken into account to evaluate the impact of industry on a community.

b. Is classifying industry as "good" or "bad" based on evaluation of it products and by-products productive?

c. How does a community weigh the advantages and disadvantages about siting a factory?

d. What standards should we use to manage earth resources effectively?

Investigating Groundwater: The Fruitvale Story

They learn about factors that affect groundwater movement and are introduced to expressing concentration as parts per million. They attempt to locate the source of groundwater contamination in Fruitvale.

a. How does groundwater get contaminated?

b. How can we make informed decisions based on evidence we cannot directly experience?

c. Uncertainty as a factor in making decision.

d. Solutions to problems generate more problems.

Chemical Survey & Solutions and Pollution

An introduction to chemicals and their relationship to societal issues.

a. Learn about the uniqueness and importance of water.

b. Is distillation the answer to pollution?

c. Use bar charts to analyze and understand trends in data.

Toxic Waste: A Teaching Simulation

Perform investigation to get rid of toxic waste.

a. Is dilution an answer to pollution?

b. Toxic wastes often contain useful materials that can be reclaimed. Reduces pollution.

c. What problems does reclaiming solve? Create?

d. Treatment and disposal of toxic wastes to landfills.

Determining Threshold Limits

Define threshold limit values.

a. Can the quality of our drinking water be determined by taste and smell?

b. How do we measure the amount of a potentially harmful substance in our water?

c. How are toxicity levels for potentially toxic substances determined?

LESSON PLAN

PURPOSE: TO GAIN A BASIC UNDERSTANDING OF A "CLOSED SYSTEM."

GOAL: UPON COMPLETION OF THIS INVESTIGATION, THE STUDENT WILL BE ABLE TO EXPRESS VERBALLY AND IN WRITING WHAT IS MEANT BY A "CLOSED SYSTEM."

MATERIALS: BALLOON - FLASK - HEAT SOURCE - BALANCE - TONGS

PROCEDURE:

1. PLACE THE BALLOON OVER THE MOUTH OF THE FLASK AND MASS THE SET-UP.

2. PLACE SET-UP OVER/ON HEAT SOURCE AND START THE HEATING PROCESS.

3. SEVERAL TIMES DURING THE HEATING PROCESS, MASS THE SET-UP. (USE YOUR TONGS AS

SET-UP WILL BE HOT)

OBSERVATIONS:

1. NO APPRECIABLE CHANGE IN MASS WAS NOTICED AS THE VOLUME INCREASED.

NOTE: BUOYANCY PREVENTS THIS FROM BEING A TRUE EXAMPLE OF A "CLOSED SYSTEM" BUT, THE STUDENT WILL STILL UNDERSTAND THAT NOTHING ENTERS OR LEAVES THE CLOSED SYSTEM.

EVALUATION:

1. THE STUDENT CAN DEFINE WHAT IS MEANT BY A "CLOSED SYSTEM" BOTH ORALLY AND IN WRITING.

2. THE STUDENT CAN RELATE THIS INVESTIGATION TO THE EARTH'S "CLOSED SYSTEM."

LESSON PLAN

PURPOSE:

TO REVIEW THE DEFINITION OF THE TERM "CYCLE."
TO REVIEW THE "WATER CYCLE."

GOAL: UPON COMPLETION OF THIS INVESTIGATION:

(1) THE STUDENT WILL BE ABLE TO DEFINE THE TERM "CYCLE" BOTH ORALLY AND IN WRITING.

(2) THE STUDENT WILL BE ABLE TO DIAGRAM THE WATER CYCLE AND EXPLAIN WHAT IS HAPPENING AT EACH STEP IN THE CYCLE.

MATERIALS: FLASK - COLORED WATER SOLUTION - HEAT SOURCE - DISTILLATION SET-UP(DEPENDS ON LAB FACILITIES)

PROCEDURE:

1. SET-UP DISTILLATION APPARATUS.

2. ASK THE STUDENTS WHAT THEY THINK WILL HAPPEN WHEN THE SOLUTION IS HEATED.

3. PERFORM THE INVESTIGATION.

OBSERVATIONS:

1. THE DISTILLED WATER IS CLEAR.

EVALUATION:

1. THE STUDENT CAN EXPLAIN THE INVESTIGATION BY DIFFERENCES IN BOILING POINTS.

2. THE STUDENT CAN RELATE THIS ACTIVITY TO THE WATER CYCLE ON EARTH.

SUGGESTED VIDEO SERIES

THE EARTH AT RISK ENVIRONMENTAL VIDEO SERIES

I recommend these videos as a means to introduce and expand population/environmental topics. Each program is 30 minutes in length and show actual environmental projects.

ACID RAIN

CLEAN AIR

CLEAN WATER

DEGRADATION OF LAND

EXTINCTION

GLOBAL WARMING

NUCLEAR ENERGY

RECYCLING

THE RAINFOREST