

Population: Too Many People?

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The Academic Setting

For the last five years I have been a teacher at Albuquerque High School in Albuquerque, New Mexico. Albuquerque High School is the oldest high school in the city, and for a long time it was the only high school in the city. Because of this fact, Albuquerque High School has a strong local following. Many of my students' families have always attended Albuquerque High School, and for some of my students it is considered a privilege and an honor to attend Albuquerque High. Many of Albuquerque High's teachers are also graduates from Albuquerque High, including the popular head basketball coach. The present building is the second site of Albuquerque High School. The first site is located on Central Avenue near downtown. That building has been vacant for twenty-five years, but the city refuses to tear it down because of its sentimental value to so many residents. There has been endless talk about revitalizing the old Albuquerque High building as a retail/residential site, and that may someday happen. The present Albuquerque High School is located a little north of downtown, next to the Career Enrichment Center. The Career Enrichment Center is a vocational high school that offers all public high school students an opportunity to enroll in more specialized classes on many levels. Quite a few Albuquerque High School students take advantage of this proximity to the Career Enrichment Center.

Today, Albuquerque High can be considered an urban high school because of the varied socio-economic status of the students attending the school. There is a wide range of family income represented by the Albuquerque High student body. Students living directly east of the high school come from upper middle class neighborhoods that surround the University of New Mexico and consist of extremely large houses with a mix of more modest homes. Students living south and west of the high school come from much older neighborhoods made up of mostly lower income housing. These older, more downtown neighborhoods have some teenage gang problems. Urban high schools make it a priority to help students whose families qualify for many social services. Albuquerque High School has an excellent teen health center, which helps students obtain referrals for outside medical services. On campus, there are two full time social workers and a drug counselor, who work with students on a per-need basis. This is beyond the regular staff of administrators that all public high schools have. It should be noted that in the academic year 1999 – 2000, one out of four Albuquerque High School students qualified for free or reduced price meals compared to the average of one out of five students for all the other high schools in the city (APS 3).

The student enrollment at Albuquerque High School is predominantly Hispanic.

The average percentage of Hispanic students for all APS high schools is 45.8%. At Albuquerque High School it is 68.1%. The percentage of Anglo students for all the high schools in Albuquerque is 42.7%. At Albuquerque High, the percentage of Anglo students is 19.8% (APS 2). Of the Hispanic students at Albuquerque High School, the majority of them are bilingual Spanish-English. These students exhibit varying levels of bilingual ability, but there are many students who speak English only at school. Bi-lingual ability is so common at Albuquerque High School that among Hispanic students, at least a passive knowledge of the Spanish language is considered normal. Besides an involvement with the Spanish language, the majority of the Hispanic students have a strong attachment to the Spanish culture, particularly that of Mexico. Many of the Hispanic students at Albuquerque High are the children of immigrants from Mexico or recent immigrants themselves.

In the United States, graduation from high school is often considered the first step towards a successful career. At Albuquerque High School, it is too often the last academic step. Albuquerque High graduates, on average, only one third of its entering freshmen class. In the five years that I have taught at Albuquerque High School, an average of 30% of my freshmen students do not pass either of the science classes (Physical Science or Biology) that I teach. There are many reasons why students do not pass freshmen high school science classes or graduate from high school, but sometimes the reason is relevancy.

In formulating a science curriculum unit on "Population," I have attempted to add a global issue of extreme relevancy to the statemandated science curriculum. Physical Science and Biology are considered by the state to be freshmen level science classes. They each run for a whole academic year. Physical Science is an introductory science class covering the fundamentals of physics and chemistry. Biology is also an introductory class covering the fundamentals of life science. Together, the curriculum of these two classes attempts to present a general science education and should, in theory, provide a high school graduate with a very basic understanding of how the world works. Passage of at least two years of science is necessary for graduation from high school in the state of New Mexico. It is my hope that all my students leave my classes with an appreciation of the importance of science in their lives.

This unit on population came out of the realization that most teenagers do not feel much connection to the problems of people in the rest of the world. Their vision of themselves and their surroundings is extremely narrow. An introductory discussion of population issues is an attempt to broaden their scientific knowledge base and help them connect to the problems of people in other parts of the world. This is difficult in New Mexico where most teenagers do not see any evidence of a crowded planet. New Mexico is not an overpopulated state. It is the fifth largest state in square miles and the 37th in population (Mattson 69). New Mexican teenagers do not see their actions as having any relation to the world's growing population. New Mexican teenagers have a high level of teen pregnancies. During the years 1980 to 1996 there were, on an average, 71 births per 1000 females age

15-19 (Casey 29). Teenagers are also great consumers. They look forward to their next purchase. They are not thinking about the uneven world distribution of resources on their way to the mall. But there is one resource issue of great interest to local teenagers; they will pay attention to local water statistics. The mention of the 30 -year life span of their underground aquifer (Gutzler interview) is guaranteed to get their attention. On the whole, my students are typical teenagers who are extremely involved with their own lives. They are almost adults and should be more familiar with the condition of the world they live in and the crowded planet they inhabit.

The curriculum unit on population that I have created meets parts of five New Mexico performance standards for high school science: numbers 1,2,11,15 and 16. The information and activities that follow will help explain to average teenagers that their actions do make a difference and that their future, based on world-wide population trends, may be very different than the present they live in now.

Narrative

The world's population today is over six billion people. China and India now have over one billion people each. Another 80-100 million people are born each year. By 2030 there will be nine billion people, and in 100 years there will be 11-12 billion people (McMichael 111). There have never been so many people alive at one time then there are today.

Besides the vast numbers of people themselves, the speed at which this rise in population has occurred over the last 100 years has been astonishing. Since the history of the human species began over eight million years ago there has always been fewer than one billion people on the planet (Biggs 463). In fact, 100 years ago there were still less than two billion people. Fifty years ago there were only about three billion people.

Twenty years ago there were five billion people on the planet (McMichael 111). Today, we are living through the fastest rise in human population growth ever seen.

Growth in human population has been noted in the past. In the early 1800's, Thomas Malthus, the first professional English economist, noted that population growth is exponential, while agriculture expands arithmetically. Malthus extrapolated that if this relationship were allowed to continue, then the only limit to human population growth would be starvation and famine (Cohen 42). Malthus' prediction did not happen and people who believe in his pessimistic predictions are called Malthusians. Today, Malthus himself would be more than surprised at how long and by what great numbers his prediction of doom has not materialized.

The rise in human population over the last hundred years can be attributed to several factors. The last century saw remarkable achievements in medicine and science.

The increased understanding of diseases and their causes can be noted as a true benefit to mankind. The germ theory of disease led to the establishment of effective sanitary practices (Zinsser 54). The introduction of penicillin during WWII led to the discovery of other antibiotics (Biggs 517). These medical advancements have increased the survival rate of children and extended the life span of adults. The increase in scientific knowledge has also affected agriculture. The ammunition demands of WWI saw the introduction of laboratory produced nitrogen (Goldberg 54). This in turn led to commercially- produced nitrogen-based fertilizers, which increased crop yields early in this century. In the 1960's genetically engineered seeds dramatically increased crop yields again as part of the Green Revolution (Goldberg 141). The scientific achievements of the last 100 years have obviously contributed to the correspondingly dramatic rise in population during that same time span.

Even before the scientific advancements of the last century, human population growth was notably different than that of other living species. Humans have been able to adapt the environment to fit their needs. Animal species must adapt to their environment. Animal species are habitat specific, but humans have historically inhabited all the land-based biomes of Earth except Antarctica. Animal species increase in a specific environment, until their numbers reach carrying capacity, which is the numerical limit that the habitat will support in terms of availability of food and resources (Biggs 118). The human species, on the other hand, grows in numbers and then uses its reasoning to increase the availability of food and resources. Homo sapiens have historically exploited the whole planet for their survival, but never in such numbers as we see today.

If humans now live in all the regions of the earth and with numbers that have never been seen on the planet before, what does this mean for the resources that the planet provides? Everything that people have, use, invent, or buy comes from resources provided by the planet. The consumption of the earth's resources is uneven. Rich countries have fewer people, but they consume more. Poor countries have more people, but they consume less. For example, America has less than 5% of the world's population, but it annually consumes 25% of the world's energy. Industrialized countries make up 20% of the world's population, but they consume 86% of the world's aluminum, 81% of the world's paper, 80% of its iron and steel, and 76% of its timber ("The Basics" 3). Since industrialized countries consume more products, they also produce more waste. The average New York City resident produces 4 lbs. of garbage a day, while the average resident of Cairo produces 1 lb. of garbage a day ("The Basics" 4). The United States also produces 23% of the world's carbon dioxide emissions, as the result of a high consumption of fossil fuels ("The Basics" 3). As the industrialized nations continue to maintain their high-consuming lifestyle, will the developing nations continue to allow an imbalance in the distribution of good and resources or will we see "resource wars" in the future? (McMichael 307).

Even in rich countries, a growing population produces its own internal

environmental and social problems. More people means more demands on land and water resources. In the United States, which is growing at a rate of 2.4 million people a year, 1.3 million acres of land are paved over every year and groundwater reserves are being depleted at a rate 25% greater than replenishment ("The Basics" 3). Social services, such as schools and hospitals, are strained because they serve more people than they were built for. As the population keeps growing older, the dependency ratio of residents over 65 to people working will also cause social financial stresses (Domniguez C12).

On a global scale, such large number of Homo sapiens affects other species. As more people demand more from the planet, the extinction rate for both plants and animals is increasing. Eighty-eight species of mammals and 116 species of birds have become extinct in the last 400 years (Purcell 143). Two-thirds of the world's bird species are endangered and one out of ten species of birds faces extinction due to loss of habitat (Seager 124). Humans are destroying natural habitats at least 1,000 times faster than the natural rate of extinction (Frequently asked 4).

With these dismal statistics what, if anything, can be done to slow human population growth? Does something need to be done at all? Some people feel that technology will produce solutions for all the world's problems, including the population issue. People feel that humans are creative enough to solve this issue and any future ones (MacFarquhar 103). Technology has made a better world for most people, but technology demands lots of money and enough time, something the world might not have (Cohen 46). Some people believe that a growing population will be able to move to another planet, Mars, for example. But once again that would take technology and lots of money and time (Cohen 44). Others believe that wars and famine will control the population. In the 20th century, wars have killed nearly 200 million people, but the population has grown by four billion, so even though Malthus predicted doom, people have survived to reproduce (Frequently asked 4). The six billion people on the planet right now are the proof of that.

Family Planning

The global population is now over six billion people. Part of this is due to the decrease in the death rate (Singer 24) and the increase in human life span from an average of 46 years in 1960 to 60 years now (Knickerbocker 4). The world's fertility rate has been dropping on a global level for the past three decades. It has gone from 6 in 1960 to 2.9 births in the 1990's per woman in her lifetime (Potts 89). But those numbers tell only part of the story. The world can be divided into two sections based on fertility rates. In the Western World, which includes Japan, the fertility rate is falling and even dropping below replacement level so that by 2050 those countries will contain a total of one billion people. On the other hand, the developing world's fertility rate remains above replacement level of 2.1 children, and by 2050 their population will double and those countries will have eight billion (Knickerbocker 2).

Seventy-eight million people are added to the world's population each year (Potts 90). If this rate is to fall, then contraceptives must be made available to anyone who wants them. Already, close to 60% of the world's couples use them, but in order to bring the fertility rate down to replacement level, that percentage must be increased to 70% (Family Planning-Overview 1). Most countries realize that unless they lower their fertility rate, they are doomed to remain poor. Small families are necessary for a country's per capita income to increase (Potts 91). Due to the ability of western nations to lower their fertility rate, per capita income has doubled on a global level since 1950 (Dye 3).

Forty-four percent of the world's inhabitants already live in countries where the fertility rate is below replacement level (Sides 35). One of the reasons for this is due to choices presented to women. When women are allowed an education, the fertility rate goes down (Goodman A12). It's almost as if modernity determines fertility (Singer 24). When there are fewer children in a family, the chances increase that they will all receive an education (Potts 91.) Women's right to choose how many children they will have in their lifetime becomes even more important when it is noted that there are three billion people alive today who are under twenty-five (Knickerbocker 2). The availability of contraceptives is crucial for this section of the population. The United States is trying to make contraceptives available without a prescription, since their safety and efficacy has been proven for many decades by the 16 million women who have taken them without any adverse side effects (Potts 93).

Ninety-six percent of the world's annual population growth takes place in developing countries (Knickerbocker 2). India's population reached one billion in May of this year (Rachman A4). That means that one out of every six people on the planet live in India. India adds 16 million people to their population every year. Seventy-two thousand are born each day in India. India is only 40% the size of the United States but it has four times the amount of people (Crossette 41). For much of India's population, the quality of life is poor. Such large numbers of people put a great deal of demands on public institutions such as medical and educational, and the food supply is often insufficient. India's only hope of economic sustainability is to increase its level of family planning (Litke 2).

Over the years, birth control has changed its name and become family planning (Potts 90). But since the world's population has doubled since 1960 maybe it should be called "Free Family Planning-Available to All."

Immigration

Most animal species migrate or move within their specific habitat in search of better availability of food sources. Herbivores in particular need to range over a wide area in order to obtain enough food. As hunters and gatherers, people migrated over large areas, even continents, in order to obtain food. Today, people's ability to move in order to improve their situation is limited by state boundaries.

People who leave their country are called emigrants, people who enter a new country are called immigrants, and people who are forced to migrate are called refugees. In a future more crowded world, the number of people on the move will probably increase.

The United Nations sees future immigration as necessary and positive for all of Western Europe and Japan. Over the next 50 years, these two areas will see a decline in population and an increase in the age of their populations. If the number of workers decreases too much, then the aging population who no longer work will have fewer people paying into their social services. In order to maintain these countries' retirement and health care systems, particularly for an older population, replacement immigration will have to be encouraged (An Older World 1).

The United States is also considered to have a slow rate of population growth and an aging population. The United Nations sees replacement immigration as beneficial for the United States too. However, there is a growing, underlying political sentiment that is against immigration. One editorial in the *Albuquerque Journal* argued that since today choice, not fate, determines births, public policy should determine the number of immigrants allowed to enter the country. The editorial went on to admit that even though America is a country of immigrants, strictly controlled immigration should be a priority in the United States if the present quality of life is to be maintained (Simpson B3). One prominent politician in another article is proposing closed borders (Buchanan C12). In the United States today, 9.6% of the population is foreign-born. For the years 1990-1996, the United States added 1.1 million people a year through immigration (World Population Growth 1). This is in comparison to the half-million people added each year during 1900-1924 who came through Ellis Island (Bunson 1).

The movement of people within their own country also needs to be mentioned. There is an historical tendency to move from rural to urban environments. In 1800, only 2% of the world's population lived in towns. By 1995, 45% of the world's population lived in urban areas and today 17% of the world's population lives in cities with $\frac{3}{4}$ of a million people or more (Cohen 223). These mega-urban areas present population problems, specifically in terms of sanitation and safety of the food supply (Samet interview.) In Mexico, 900,000 people a year leave rural areas for the cities (Watson B8). In Mexico City alone, there are over 1,000 tortilla factories, all of which can never be inspected for proper sanitation (Samet interview). In 1990, Cairo had a population of 12 million people and it relied on a water and sanitation system designed for 2 million (McMichael 279).

Often, immigration is a choice of desperation. People are willing to risk their lives to try for a better life in another country. The famous saga of Elian Gonzales, a six-year-old boy from Cuba, who was the only survivor of an attempt to immigrate to America in November 1999, is one example. Recently, 58 Chinese immigrants suffocated in a produce truck in an attempt to reach England (Woods A8). Monthly, 20,000 illegal immigrants from Mexico cross the desert and are taken

into custody at Douglas, Arizona, and sent back to Mexico (Buchanan C12). Immigration to these people must seem like the only choice.

Food

All animals need a source of food. In the 10,000 years since agriculture has been discovered, the human population has been able, in general, to maintain a steady supply of food that has allowed its population to grow. Scientific advancement of the last hundred years has not left the agricultural sector untouched, and the increase in food production on an agro-business scale has supported the large population growth of the last century. However, there are alarming statistics that point to a different contemporary and future global food situation.

Today, there are 800 million hungry people, mostly in the developing world (The State 1) Two to three million children die each year of hunger and three to eight million more die of hunger associated diseases (McMichael 217). The rapid population growth of the late 20th century has canceled any gains in increased food production made by many countries (Goldberg 145).

In order to feed the world's population by 2030, world food production must double (McMichael 217) which looks unlikely. 11% of the earth's land is now used for food production (Goldberg 143) and there isn't much more to bring under cultivation (McMichael 218). Meat production has stayed constant since 1987 (McMichael 204). Grain production has gone up by 1% while rice production has dropped 1% in the most recent statistics for 1999 (Cereal 1). In 1996, the oceans supplied 15% of the world's protein due to an increase in aquaculture or fish farming (McMichael 231). However, there has been a decline of wild fish catch of 7.5% during the years 1997-1998 and 60% of the world's ocean fisheries are fished at or beyond capacity (BizFacts A7).

Besides unimpressive food production statistics, the quality of the land has declined. One percent of the world's topsoil, where the crops are grown, is lost each year

(McMichael 215). As the world's rainforests are being cleared for agriculture by traditional slash and burn techniques, the necessary 20 year fallow period is not being followed due to pressure to produce crops and the land becomes sterile (Brause 21). Genetically engineered seeds that do produce higher crop yields, need constant supplies of chemical fertilizer which rob the land of its original nutrients and break organic cycles (Watson B8). The quality of drinking water supplies is affected by polluted run-off caused by the amount of fertilizer necessary to grow crops on poor soil (McMichael 205) Increased use of pesticides also contributes to this problem of polluted water supplies and has created another problem in the need for ever stronger pesticides as the pests become resistant to existing poisons (Peckham 29.)

Hunger is a contradictory world situation. Rich countries have people dying from

diet related causes. Rich countries pay farmers not to plant certain crops. Poor countries have people dying because of poverty, political instability, and because those countries often send food crops to rich countries to gain income (McMichael 215).

The United Nations has a food goal for the future. They would like to halve the world's population of hungry people to 400 million by 2015 (The State 1). They would like to increase the level of "food security" for the majority of the world's inhabitants. The United Nations says that is a birthright to have enough to eat (The State 1). But with almost one out of six people in the world hungry today (Goldberg 142) how is that goal to be met? The pressure today to feed six billion people seems to have reached a certain unsatisfactory limit. Unless certain things can be changed, such as even more effective agricultural practices, increased and more equal distribution of food, increased caloric intake for millions of people, the specter of famine still looms for many.

Living Standards

The world-wide disparity of living standards contributes to the high level of population growth exhibited by the developing countries. If citizens of a country are insecure about who will care for them in their old age, then they feel obliged to have more children as a type of old-age insurance. If a percentage of these children die before they reach adulthood, then the compulsion to have more children so at least a few will survive, persists. If children are necessary for a secure future, then anything that limits childbirth, such as education for women and access to birth control methods will be denigrated. More children predicate lower living standards. The statistics that compare worldwide living standards are compelling.

Health care standards are quite different in developing countries as compared to the developed world. In Mali, the ratio of infant mortality is 154/1000 births, compared to Great Britain where the ratio is 7/1000. In Mali, there are almost 20,000 people to one physician. Compare that to 630 people to one physician in the United States (Menzel 248). In sub-Saharan Africa 1/21 women die in childbirth, while in the United States, the ratio is 1/6366 (Tobias 264). The life expectancy of someone in Japan has risen to 74.5 years, while someone in Sierra Leone can expect only 26 years of good health (Moulson A10).

Employment statistics and what employment can buy are also different. In 1998, 22% of the world's population lived on \$1 (Toros B7). Unemployment in the United States is at an all time low, while in the developing countries it is at an all time (Toros B7). In Kenya, only 30-40% of adults are employed. The minimum wage there is \$22.00 a month (Tobias 270). A monthly salary based on minimum wage in the United States today is \$989.00. In India in 1994, the average yearly per capita income was \$330 (Menzel 248). In Mongolia, 68% of a typical family's income is spent on food (Menzel 45). In the United States it is only 9% (Menzel 248). With so little of a typical family's income spent on food, it is no wonder that the United States is such a high consumer of goods and services. Ninety percent of

households in the developed world (including the United States) have phones. In the developing countries it is only 17%. In the United States, one out of four people have access to the Internet, in Africa it is only one in 4,000 (Knickerbocker 5).

Educational statistics are also quite different. In the developed world, only 2% of primary age children are not in school. Throughout the world, 80% of primary age children are in school, with the absent 20% coming from the developing world (Knickerbocker 4). In the United States 12 years is the average time spent in school for people over 25 years old (Menzel 248). In India it is two years (Menzel 248). In Iceland, the average literacy rate is 99.9%, while in Mali it is 32% (Menzel 247).

If inequality of living standards becomes too obvious due to proximity, then people will often resort to desperate measures. In Zimbabwe, landless black citizens have begun to take over white owned farms. There have been 1,400 farms affected so far, and the newly elected majority government wants to nationalize all white owned farms, without compensation (Shaw A12). Is the inequality of worldwide living standards the result of unequal population growth, or does unequal growth cause unequal living standards?

Population Issues in Literature

One of the reasons that there are six billion people alive today is that modern society has been able to prolong and extend people's life span. With the realization that everyone tries to avoid death, many authors have also included an extended life span in their books. Often authors have very complete visions of what an extremely extended life span would be like. I have found three relatively unknown science fiction novels that deal with both population issues and extended life spans.

Trouble with Lichen by John Wyndham and published in 1960 is about a young female biochemist that discovers a compound in an obscure species of lichen that retards aging. She then moves to London and opens up an exclusive beauty salon where she sells her treatments and makes lots of money. She had decided to turn this compound into beauty treatments for women so that they could extend their biological clocks and not have to make a choice between family and a career. Unfortunately, her boss at the biochemistry lab also discovered this compound and had given yearly treatments to his children. When all this came out and a nasty daughter-in-law tried to sell this compound to the highest bidder, it caused a few disappearances and a faked death. The limiting factor to extending everyone's life was the availability of the lichen, because apparently the compound couldn't be synthesized. The ending is sweet, with the biochemist and her now widowed boss retiring to a country home to live out their extended life spans of 300 years together, working out biochemical problems.

Time of the Great Freeze by Robert Silverberg and published in 1964 is a more futuristic story. It talks about the earth in the year 2659 when the northern parts are just coming out of the Fifth Ice Age. The cities up north had to move underground

when the ice began to expand and the tropics would not accept anyone fleeing the cold. In these underground cities the population is strictly limited. Each citizen has the right to reproduce a replacement copy of themselves and reproductive rights can also be taken away if the citizen breaks any laws, the rationale being that population control was easier than expanding the underground city. Also, for some unexplained reason, the average life span underground is between 100 and 120 years. These facts are just an aside to the adventures a brave group of men have while exploring the slowly melting surface, but they still point to a future where population issues had to be resolved.

The Blue Chair by Joyce Thompson and published in 1977 is the most complete study of a society of immortals that I have ever read. It talks about some nebulous time in the future when treatments are available to make people live forever. But there is a catch; if you take the treatments, you can't have children. It also mentions how the parents of these people were the last generation to die. These treatments are available only to people of a certain color in a certain part of the world, chaos and famine plague the rest of the world. This future society also imports workers from the undeveloped world and the workers are treated as second class citizens. The book revolves around one woman's decision to have children and grow old in a society where people don't. It is a thought-provoking novel where the fear of living alone forever is a reality.

All three of these science fiction novels deal with interesting aspects of population control and age span. Even though they were all written a while ago, I found the authors' concerns to be extremely contemporary.

Implementation

The curriculum unit on population can be covered in two weeks or ten 50-minute class periods. In these two weeks, there are two full days of lecture material and two days spent outside of the classroom in the library and the computer lab. The other six days are spent in the classroom and include such activities as watching a movie, commenting on newspaper articles, graphing and map reading skills, playing a few resource games, figuring out exponential growth on paper and whole class discussions. All of these activities are appropriate for freshmen high school students, and there is time in each 50-minute class period to account for various ability levels and/or explanations and some discussion time. Eight ways of generating grades or assessment, including five in class assignments, two homework assignments, a book report, and a general grade for class participation in a discussion, are included in this two-week unit. A final assessment for the unit is not included but that could be easily added if it was deemed necessary. Parts of five New Mexico state-mandated secondary science standards are covered in the unit. This curriculum unit is presented as a collection of ten days of continuous study on the issue of world population, but each of these activities could be interjected as needed into freshmen biology or physical science classes and modified to fit each teacher's own style and preferences. What follows is a list of

the lessons in the order that fits my teaching style. The materials needed to teach this unit should be readily available to all high school teachers. I have listed them before each lesson. Outside of the two videos, the other materials are very ordinary. It should be noted that at Albuquerque High reservations, which have to be made many days or even weeks in advance, are needed for both the computer lab and the library.

Day One- Need VCR and short seven minute movie by the organization Zero Population Growth entitled "World Population." This movie is a real attention grabber and it graphically shows world population growth over the last 2000 years and continues on into the future stopping at the year 2030. Students are not required to take notes during this short movie, which can be viewed twice for maximum effect. Students are required to take notes (in their science notebook) during the lecture that follows. The 30-minute lecture should include history, statistics, and facts about human population growth over the last 2000 years. Projections for future growth should also be presented. Included in this lecture should be a short explanation of how animal populations grow and are controlled by habitat, food supply, and the presence of predators. The movie and the lecture meet state performance standard 11. The movie and the lecture present students with the necessary information needed to identify carrying capacity of an ecosystem and allows students to predict limiting factors slowing population growth (11 E-1). Students will also be presented with the necessary information needed to identify predator/prey relationships within an ecosystem (11 E-2).

Day Two- Need enough maps and atlases showing world population data so students can share reference material in groups of about three. Also need blank maps (try the social studies department) that students can fill in with a legend that they have created. The distribution of reference material turns this lesson into a group situation, but even with groups, I require every student to turn in his own map. In 1998, the National Geographic Society put out an excellent population map and a bio-diversity map and at the bottom of each map there are instructions to contact the National Geographic Society (www.nationalgeographic.com) for information about obtaining more maps. Once students are acquainted with the various legends on the reference maps, they are required to create a legend of their own and fill in world human population data using their legend on the blank map. The maps are collected at the end of the period because the reference materials cannot leave the classroom. For students needing extra time, they might be able to come in at lunch or during a study hall to finish the assignment. This lesson meets state performance standard 11 because it allows students to choose geographic regions and document the interaction between people and the regions (in this case the whole world) ecosystem (11 F-4).

Day Three-computer lab (or whenever it fits into the schedule.) It is ideal if each student can have his or her own computer for this assignment. There are several excellent web sites about population and the effects of population that students can view. A simple assessment to be collected at the end of the period could be a list of

five or ten new population facts that students found by visiting the sites that are listed on the board or printed up on a handout. The assignment could also be presented as requiring the student to find five new population facts from each of the three web sites to be visited during the class period. The three web sites are www.popexpo.net, www.zpg.org and www.amnh.org. All these websites are excellent and easy to use. Popexpo.net is the web site of the Museum of Man in Paris, France. It is an interactive web site that takes the viewer through a population questionnaire and the whole time a population clock is ticking off. ZPG.org is less interactive but it is also a good web site for students looking for population facts presented in a clear manner. There are also a lot of interesting links on this web site. Amnh.org is the web site of the Museum of Natural History in New York City. It has a permanent exhibit on bio-diversity with many facts about endangered species displayed in a colorful manner. This is an easy to use, graphically interesting web site. For one 50-minute class period, these three web sites are engaging enough for most students. This activity meets state science standard 11 because it presents students with information that will allow them to predict the impact humans might have on species and environmental systems (11 F) and to explain possible consequences in reduction of bio-diversity and to understand what diversity means to ecological stability (11 F-1).

Day Four-this day consists of one class activity, one demonstration, and one homework assignment. A bag of colored M&Ms, a few apples, and a kitchen knife are required. The game involving M&Ms comes out of the book Earthsearch by John Cassidy and the spinner needed for that game is on pg. 89. If that book is not available then a spinner divided into 17%, 26%, and 57% would have to be constructed. The M&Ms game is an extremely graphic way of showing students how the world's resources are divided. The first thing that has to be done is to divide the M&Ms into three piles. There should be one pile of 50 red M&Ms, one pile of 30 yellow M&Ms and one pile of 20 green M&Ms. The M&Ms can be collected into cups. Then all students in the classroom are instructed to spin the spinner, and they are divided into one of three groups depending on where the spinner puts them. Once the students are all in their groups, they can then divide up the appropriate pile of M&Ms. They will quickly realize that the smallest group of students gets the biggest group of M&Ms to divide. Once the students have sat down, the teacher can begin the demonstration with the apple. This apple cutting exercise comes from the Zero Population Growth Organization. First the teacher explains that the apple represents the planet Earth. Then the teacher cuts the apple into quarters and sets aside three quarters of the apple. Those three -quarters represent the oceans. The fourth quarter is land. This last quarter is cut in half. One of those halves is set aside. That represents all the land that is uninhabitable. Hold up the 1/8 remaining and point out that all the people on the planet live on this part. Now, cut this remaining 1/8 into four parts. Set aside three sections so that only 1/32 is left. Those 3/32 sections represent areas that are not suited for growing food and are places such as cities and roads. Peel the 1/32 that is left very carefully. The peel represents the topsoil on which the world depends for food production. This

little demonstration should sufficiently impress most students on the size of the earth's food production system. Now you can start the homework assignment. Instruct students to take out one piece of paper. On one side they are to write "Two Offspring" and on the other side they are to write "Three Offspring." Have them start by putting two parents on the top of each page. The parents can be represented by stick figures, straight lines, little boxes, circles or any symbol that the student feels comfortable with. Then have the students give the parents two offspring or three offspring on the appropriate side. Tell the students to space out the first generation offspring a little bit because they are going to have to continue giving each generation either two offspring or three offspring for seven generations total. This exercise tries the patience of most students, so it makes a good homework assignment that is to be collected the next day. These charts graphically illustrate exponential growth, and even though the generations die, they still demonstrate population growth. These three activities meet three state science standards: 11 F-2, 11 E-3 and 1. The M&M activity meets state science standard 11 because it shows students how industrialized nations use resources compared to how developing nations use resources (11 F-2). The apple cutting demonstration meets state science standard 11 because it identifies carrying capacity of an ecosystem and shows students a model for growth limitations (11 E-1). The "Seven Generation" growth exercise meets state science standard 2 because it helps student evaluate information derived from prediction methods to solve science problems (1 B-1).

Day Five- Need VCR and movie entitled *Planet of Life: Evolution's Next Step*. This is a Discovery Channel movie that came out in 1998. The movie gives an excellent summary of human population growth and details the pre-historic spread of man throughout the continents. It also ties in cultural advances, such as the invention of agriculture, with world wide climate changes. Students may find the second part of the movie more interesting because it gives a scientific overview of terra-forming Mars and making it fit for human habitation. The self-contained living experiment called "Biosphere 2" outside of Tucson, Arizona, is mentioned and some of the students may have been there. For movies, I usually ask the students to write down five science facts while they are watching the movie. Any other way of generating a grade for this activity would also be acceptable. This activity meets state science standard 15 because it presents students with information needed to analyze the limitations of science and technology to solve human problems and social challenges (C).

Day Six-Library (or whenever fits into the schedule.) The object of this part of the unit is to require students to read a science fiction book. The librarian should be consulted before bringing the students to the library to make sure there are enough books to support this assignment. If there are not enough science fiction books for all students, then students could be given the choice of reading a book of science fact, specifically on an endangered species. The librarian should be able to generate lists of books covering both topics. All the books need to be approved by

the teacher, and students should be encouraged to start to read their books before they leave the library so that they can be sure they are appropriate. Either before the students go to the library or at some point after they have checked out their books, the assignment can be explained. Any book report format can be used, but I prefer an extremely simple one that I have used successfully. This format consists of two parts, the first part is just a simple short summary of the book and the second part is an attempt to convince me, the teacher, to read the book. This part of the curriculum unit does not have to be finished during the two weeks that were initially described. The due date for the book report can be whenever it fits into the rest of the semester course work. If the librarian is willing, this is an excellent time for a discussion of the science fiction genre. Even though this is a science class, it can be explained that many science fiction books have a great deal of science fact in them. This assignment meets state science standard 15 because it encourages students to think about the social impact between science and technology (15.)

Day Seven- Need newspaper articles. Students need to realize that science is news. To do this, I have a method that grades students on their ability to discern fact from fiction in a contemporary news event. Before this assignment can be given the teacher must collect and copy about ten (or fewer) newspaper articles about population or ecological issues. Twenty copies are made of each article. I usually put the articles on the front and back of a piece of paper. This activity takes quite a bit of instruction because it is hard for students to tell what is factual and what is opinion in newspaper articles. Once the articles are passed out, I tell students that they must write down two facts from each article and two of their own comments about each fact. The articles should be alternated when passed out so the students won't use the same facts. For one class period, I require the students to read two articles. If they do more, I count that as extra credit. This assignment takes place during one class period. I have found that some students require a lot of instruction for this activity, while others do not. This activity meets state science requirement 16 because if students are exposed to newspaper articles that deal about ecological issues then they are evaluating human activities and the potential they have for increasing or decreasing environmental risks (16). The newspaper articles will also help students identify the major sources of pollution on a global scale (16 B-2).

Day Eight- This day is built into the schedule for teachers to catch up on some of the activities or to allow for a day of classroom generated discussion. This day can also be used at the end of the curriculum unit, but I included it here to show how it could work. Population issues are extremely complex but there are two facets of population that can be divided into yes or no questions and presented as possible debate issues for student-generated discussions. The first question is about birth control. Is it necessary or not and for whom? The examples of China's state mandated birth control system and India's more democratic, individual choice system can be presented. The other question could be about immigration. Is it necessary to control immigration between countries or should people be allowed to live anywhere they want? The choice of which of these two questions to be

debated could be left up to the individual class or the teacher could decide the choice. The method of the debate can also be left up to the teacher, but it should involve dividing the class into at least two sides. Points could be given to the side that comes up with the most valid reasons for each side of the question. This debate format could be assigned before the students come to class so they would have time to prepare their facts more thoroughly or time could be given in class to prepare the argument. I prefer to use the second option and conduct the discussion among the two opposing sides and the debate during one class period. Often students do not prepare assignments like this before class. Either way, the debate format meets state science standard 15. By allowing students to explore two sides of a social issue, they can identify areas of human endeavor that science is not well suited to address (15 C-1).

Day Nine- By now most students will have grasped the idea that the world is a crowded place. Zero Population Growth has two more classroom activities to reiterate the point. The first activity is called " Everything is Connected." This is a teacher directed activity. The teacher writes the words "More People" in the middle of the board. Then the students are asked to suggest some things that more people might lead to, and the teacher writes these things in circles connected to the original concept of more people. All reasonable suggestions should be accepted, and the students should be encouraged to consider social, economic and environmental factors. This web of ideas stays on the board during the next activity. The second activity is called "Needs vs. Wants," and is an individual assignment that is collected at the end of the period and graded. Instruct students to take out a piece of paper and fold it in half. On the left side they are to write down all the things necessary for human life, such as food, water, clothing and shelter. On the right side they are to write down all the things they want such as a car, a TV, a VCR and a stereo. Encourage them to make a long list of specific wants. Beside each want, they should write down one or two resources that those wants consume, such as oil and electricity. When the students have finished their want list, tell them to cross off three things on the right side so that people who lack the basic necessities listed on the left side can survive. Once that is done, tell them that they need to cross off another three wants since there are more people all the time. After they complain, ask them to turn the paper over and write a paragraph proposing solutions to the problem of unequal world distribution of resources. These solutions can be things the student can do or things governments can do. The paragraph and the "Needs vs. Wants" list is collected to be graded. If the students need more time, this can easily become a homework assignment. This assignment meets state science standard 11 because it makes students compare the use of natural resources in developing and industrialized countries (11 F-2) If possible, the book *The Material World* by Peter Menzel can be shared with the class.

Day Ten-This is the final activity dealing with population and it is a lecture. Questions and comments by students should be encouraged. Students are required to copy the notes into their science notebooks. By doing so, the information on

population now has become part of their science class and questions can be included in their next exam. Any points that were not mentioned in the first lecture need to be stated now. Bio-diversity and environmental degradation should be mentioned. More food statistics can be presented and students should be made aware of the high level of consumption they are part of in the industrialized world. Future projections for population growth should be explained and the birth and death ratio of modern life needs to be outlined. The aging of the population is also a good topic to include. Birth control statistics should also be mentioned. It is hoped that by including a lecture at the end of this unit on population, students will remember and respond to this global situation. This last lecture meets state standard 1 because it evaluates information to solve science/social problems (1 B-1).

It is my hope that after spending time on these ten lessons, students will have a better understanding of the world they live in. The more information high school students have, the better prepared they will be to make informed choices as adults.

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