Basic Population Curriculum For Middle School Students

Introduction

This paper presents the main concepts of a population curriculum that needs to be taught to young people throughout the world. It is a middle school curriculum that will likely take less than one week.

Our schools don't teach that the planet is finite, that there's a limit to how many people can be alive at one time, and that we cannot invent ways to create increasing quantities of food forever. Schools and parents, and thus society in general, do not teach these concepts, and this means each individual is left to sort out the competing views. For example, the following quote is from an educated person on an online philosophy forum: "I think we are all aware that the earth is a finite size and is made of finite materials…Your argument seems to be that there will come a time when we will no longer be able to improve our productive capacities…" This comment reflects trouble in reconciling two different concepts: the fact that humans seem to be able to invent more and more things and the fact that the Earth is finite.

There are experts on population issues, such as demographers, but in reality we can all be experts. Essentially each of us has the power to determine the population size. Given the unprecedented increases in human numbers in the past century and increasing environmental problems, it is essential that the individuals with the power to choose population size know the basics of demography, so that we can make the right choices. It should be difficult, not easy, to find people who will say there's no limit to how many people the planet can support.

Notes on Terminology

While I am very knowledgeable about the population issues we face, I am not a formally trained demographer or a noted expert on population issues. This gives me both an advantage and a disadvantage at the task of developing a curriculum on population for young people. A disadvantage might be that at first glance, a demographer might have trouble with the way I present the material. As you will see, I don't use some of the terminology that a demographer would expect to find.

However, as you will also see, using different terminology can work to the curriculum's advantage. Demographer's terms, in many cases, aren't necessary for the bulk of us, at any age, to understand the basic concepts of population. Throughout this paper, you will see the phrase "average number of children." It is essentially the same as the Total Fertility Rate (TFR). I don't use TFR because while it was created by demographers to make their studies a bit easier, it is a lot to digest for the masses. (From Wikipedia, TFR "is the average number of children that would be born to a woman over her lifetime if (1) she were to experience the exact current age-specific fertility rates (ASFRs) through her lifetime, and (2) she were to survive from birth through the end of her reproductive life.") The "average number of children" is what you would get if you asked every adult, "how many children did you create?" Each child will be counted twice, once by the man, and once by the woman. Additionally, most people will not naturally count the children that died, which means that I can use "2" instead of 2.07 or 2.1 for the replacement rate.

Basic Population Curriculum

Populations Grow or Shrink Exponentially

It takes 2 people to make a baby. Each parent replaces their number when they have two. If you have more than 2, you will permanently increase the population and if you have less than 2, you will bring it down. You might think that the increase is not permanent, because those children will eventually grow up and die. This is true, but they will likely have children before they die. If they have more than 2, the population will continue to grow and grow.

Two examples illustrate the speed that a population grows. If 2 people and all of their descendants average 4 children, each generation will double in size. It will take 32 generations, or approximately 800 years, for these 2 people to have exploded their numbers from 2 to 4 billion. Similarly, if 4 billion people and all their descendants choose to average 1 child, then 800 years later their numbers will have shrunk to two. (Both of these examples assume that childhood mortality is near zero, like we find in developed countries today.)

At The Limit

The planet we live on has a finite size. This means there is an absolute limit to how many people can be alive on the earth at one time. We don't know the number of people there will be when we reach that limit, and never will. Better technology can allow more people to be alive at one time. For example, more humans can be provided for if we use farming techniques instead of using just hunting and gathering techniques. But, because we are on a planet that has a finite size, there is some limit that we cannot overcome. One way to look at it is to answer whether all molecules on the planet can be part of a living human at the same time. Clearly this is impossible, thus the absolute limit must exist and must be below this number.

At the absolute limit, the number of people cannot increase. Each birth is offset by a death. To illustrate what happens, imagine the limit is sixteen. Imagine that these 16 people are spread over four generations. There are 4 children, 4 parents, 4 grandparents, and 4 great grandparents. Each generation is separated by 25 years, because the parents create their children when they are 25. (see Figure #1).

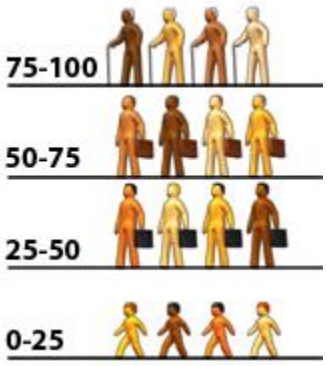

Figure #1
Note: you can
imagine that each person
represents any number
of real people

The 4 great grandparents die of old age right before their great grandchildren give birth to the next generation, when they are almost 100 years old. If the new parents average 2 offspring (ask each parent how many children they have and average this number, each child is counted twice see “How do we calculate that average?” below), this situation can go forever.

If the new parents average 3 children, there will be 18 people alive, and that means there are 2 extra people that the environment has to provide for. Two must die. The parents of these new children will certainly be stronger and more capable than the new great grandparents that just turned 75, so two of those great grandparents will die at the age of 75. Two will be able to live to old age of one hundred.

Now consider what happens if the next generation of parents resume producing 2 children each. These new parents will number 6, so they will produce 6 total children, and that means that all 4 great grandparents will die at seventy-five. The next generation will bring in another set of 6 children, and that will cause not only all four new great grandparents to die at 75, it will cause two of the new grandparents to die at fifty. This situation can go on forever, but notice that the birth of 2 extra children once in the history of this world, permanently reduced the average life expectancy from 100 down to sixty-six (see Figure #2).

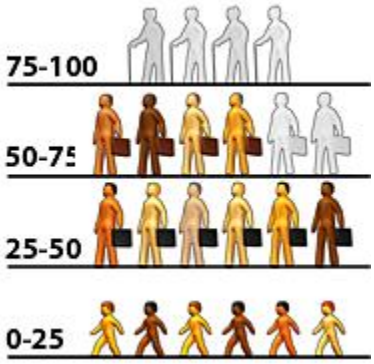

Figure #2

If each successive generation produces 3 children each, the next generation will produce 9 babies, and thus all but 1 of the new grandparents will die at age fifty. Only 1 will live to seventy-five. When those 9 babies grow up, they will bring 13.5 children into the world, but to keep this simple, we will round that down to thirteen. With 13 new mouths to feed and only 16 servings to go around, it is not obvious who is going to die, but we can take the extreme situation where all the children survive. This means only 3 parents will live, and thus 3 parents will provide for 13 children. When those 13 children reach adulthood, they will produce at least 19 children. That means that all 13 new parents and the 3 new grandparents will die, and 3 of the new born

children will die. There will be 16 children and no adults. When those 16 reach 25, they will produce 24 children, and 8 will die, leaving 16. This can continue forever, which means that if the people average 3 children per person, then 1 in 3 children will die.

Of course 16 infants cannot provide for themselves, so we will consider a more rational case where we ensure approximately 3 adults for 2 children. This will end up in the steady state where there are 6 parents, 4 grandparents and 6 children. When those 6 children produce their 9 babies, 3 babies will die, and again we see that if the society averages 3 children per person (see Figure #3), then 1 in 3 die.

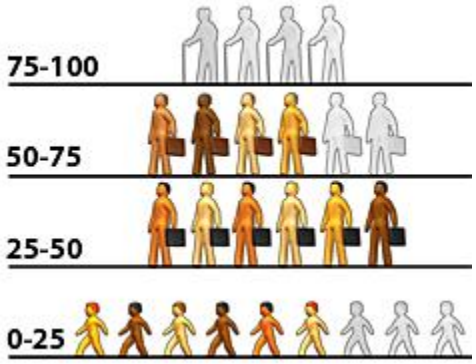

Figure #3

Consider the situation where the children die instead of an adult, so that all adults will die of old age at one hundred. In that case each generation will produce 6 babies and 2 of those babies will die. Again, if the population averages 3 children each (see Figure #4), then 1 in 3 children will die.

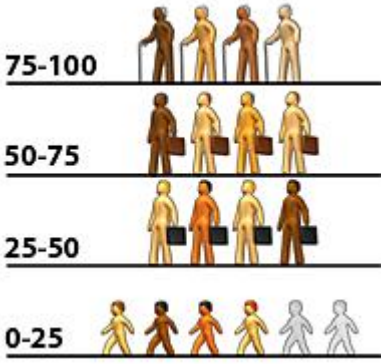

Figure #4

At the population limit, if society averages more than 2 children, and attempts to keep all those children alive, they will not succeed. Subtract 2 from the average number of children people have, and that's the number that will die no matter what we do. By attempting to save their lives, the life expectancy of the adults will drop to some miserable level and more absolute numbers of children will die. This means that at the limit, it is better to practice infanticide than average more than two children. Or to put

this in perspective with modern birth control, all forms of birth control, even abortions and infanticide, are morally superior to averaging more than two children.

A More Realistic "At The Limit"

We can add more realism to the simple example above. We can easily add more people by imagining each person represents any number, for example 1 billion. We can also spread the ages of the population out like the real world. Neither will change the logic and the conclusion one must draw from this example.

In the example above, the average number of children was either 3 or two. The logic and conclusions do not change with different averages. The math is simple enough. The excess births over an average of 2 must die before becoming an adult. For example, if the average is 5, then 3 of 5 children must die. If the average is 2.5, then 1 in 5 must die.

We can also think about what must happen if the limit changes. The limit could rise or fall over the course of some numbers of generations, for example, if the energy of the sun changes for a few centuries to some level that is more or less advantageous for growing crops. If it increases linearly, the population can handle some number of additional births once, but it cannot sustain an average above two. For example if the limit doubles (this is linear because it is a one-time doubling), then one generation of people can average 4 children. Subsequent generations must return to an average of two. It will take a few generations for that new generation to grow and reproduce, but after a few generations the population will have doubled. If the limit increases exponentially, then the average births can be above 2 according to how fast that limit is increasing. However, it must be noted that the absolute limit cannot be changed by humans. If it rises or falls, it is totally out of our control. There's no way it can change exponentially.

An additional reality that affects our understanding is to factor in early deaths that bring the population below the limit. Consider the initial situation shown in Figure 1. If an adult death happens due to say an accident or disease thus dropping the population to 15, an additional child can be born to bring the number back to sixteen. However, that generation of children will number 5 and those 5 should not average 2 children when they become parents. If they do average 2, their children will number 5 for a total of 10 parents and children, forcing 1 of the grandparents to die. This means that the society should not produce an additional child to replace an adult death. If a child dies, an additional child to replace that one does not cause a similar problem.

Getting to the Limit

The example above, "At the Limit," shows what has to happen to keep a population stable. The number of children must be controlled. Specifically, if we average more than 2 children, the population will grow, and eventually hit the limit where nature will force children to die.

Population experts will point out that the age that people have their children and the average life span will also affect the population size, but these can only affect it over the short term. Both of these factors have essentially the same upper and lower limits, which is the age range that

humans can give birth. Before a certain age, and after a certain age, we can't have children. Which is to say that we can stabilize our numbers by changing the average age when we have children, but this works for only so long. If we delay long enough, it turns into not having children. Thus, the only factor that determines whether we hit the limit or not is how many children we average.

How Do We Calculate That Average?

How many children we average can be calculated by asking all the adults how many children they have produced, and averaging those numbers. Notice that each child will be counted twice, once by the mother and once by the father. This means the zero growth number is 2 per adult, not 1 as you might expect. However, we need to factor in the death rate of children. If 1 in 3 children die, then we need to average 3 children, in order to keep the population stable. Or to put it another way, we need to replace the children that die. This creates a problem, however. Some number of those childhood deaths might be caused by the fact that we are bumping into the limit of what can be provided for. We need to know which situation we are in, depicted in Figures 1 or 3 above.

Historical Situation

Over the course of human history, the birth rate has never been controlled by the different societies, religions, or countries to ensure we keep our numbers below the limit, and human history is plenty long enough for the population to have reached the limit. This means that humans have always been bumping into the population limit. The exceptions for when we are below the limit are right after we improve our technology, or right after some population crash. This doesn't seem right because the population of humans alive at one time has never been near the level it is at now, so the obvious conclusion is that it was never at the limit. This is true in the sense that we've never been at the absolute limit, but not true with respect to the limit of our technology at each time throughout history.

There are 3 different population limits need to be defined to understand this:

1. **Sustainable Limit:** There is some limit to the number of humans that can be kept alive sustainably. This is commonly known as the carrying capacity. This limit changes with the environment and with human technology. For example, if we discover a better technique for acquiring the food we need, for example farming, the limit will rise. If a volcano erupts and spews dust into the atmosphere that reduces the crop yield, the limit will drop.
2. **Unsustainable Limit**: This is the maximum number that can be kept alive at one time, including the use of unsustainable means, given the current technology. This limit is higher than the sustainable limit, but it too can change with the environment and our technology. No species, including humans, can have numbers above the sustainable limit forever. Eventually, the resources we are consuming faster than they renew will run out.
3. **Absolute Limit**: This limit is the highest number of humans that can ever be alive at one time using the best possible techniques. The earth has a finite size; therefore there are a maximum number of humans that can be alive at one time.

The unsustainable and sustainable limits depend on our current skills at getting the resources we need to live. Examples of these skills or inventions are farming techniques, money, and the internal combustion engine, to name but a few. Our technology has generally been improving over history, thus these limits have changed and generally risen. Each time the limits increased, the death rate of children has dropped, (and a general improving of the living conditions allows the birth rate to rise), allowing the population to grow. Once the population grew back to the limit, the death rate rose to eliminate the births above an average of two.

In general, this means that we expect every country to be in the situation that Figure 3 describes. The only way around that would be if the people recently managed to increase the limits, by employing better technology faster than their population grew.

Unsustainable Limit – An Example

Humans have generally not hesitated to use nonrenewable means to stay alive, so we can safely say that throughout history humans have been continually bumping into the unsustainable limit. A fine example of a society bumping into the unsustainable limit and suffering for it can be found on Easter Island.

The inhabitants of Easter Island chopped down trees to make boats to fish for food. The boats allowed them to catch larger fish more efficiently. Neither the trees nor the boats were eaten, but without those boats they couldn't feed their numbers. As the population of the island grew, they needed to chop down more trees each year because they needed to make fishing trips proportional to the number of people on the island, and the boats wear out. When the number of trees chopped down each year exceeded the growth rate of the trees, the island had exceeded the sustainable limit. They were overpopulated. The inhabitants did not feel the effects of overpopulation until the trees were depleted to the point where they could not make enough boats. When that happened, the population crashed from above 20,000 to below 2,000, which is to say that thousands died of starvation. The highest population level they reached was their unsustainable limit. Their sustainable limit was at the point where the trees grew as fast as they were cut down.

Undeveloped Countries

All the third world or undeveloped countries have populations that are similar to Figure 3. They have low life expectancy and high childhood mortality rates. There are 2 parts to the solution to get out of this situation. We must average 2 or fewer children in order to have any hope of a solution. Even if that is accomplished, the country still needs to move from Figure 3 to Figure 1, which can happen by increasing the limit of what can be provided for by making sure those countries use the best technology. This includes not only chemicals, and tractors, but also politics, education for women, equal rights for women, and health care. However, it is critical to understand that the only long term solution is to ensure we average 2 or fewer. When a country can ensure they average 2, and average less than 2 for some amount of time, they will move from Figure 3 back to Figure 1. In short, improving the technology is not required, and in the absence of controlling the average number of children we create, it is only a short term solution.

Any country or region that has never managed their numbers and is suffering high childhood mortality rates, is suffering the effects of overpopulation. Births are causing the deaths of children.

Developed Countries

The developed countries are not in that situation. They are generally more like Figure 1. Roughly speaking, for the past 500 years the inhabitants of North America have enjoyed a nonrenewable limit that has risen faster than the population has risen. When the Europeans, around the year 1500 (and possibly the Chinese in the early 1400s) landed on North America, they unknowingly spread their diseases and wiped out a large percent of the native population. This brought the population well below the limit. In addition to starting with a population below the limit, Europeans also brought along technology that allowed a much greater population than the technologies that the natives were using, so immediately the inhabitants of North America were well below the unsustainable limit. Over the course of the next 500 years, they managed to increase that limit faster than the population grew.

Notice that “short term,” “temporary” and “long term” have been used in this paper, but not defined. We don't need any specific values for these because it is sufficient to know whether we are doing something unsustainable or not. If it is unsustainable, we must change our ways. Most importantly, we must not make the mistake of using that 500 years as proof that we can grow our numbers forever, or that technology can always be advanced to support our numbers.

Over the Sustainable Limit

When it comes to sustainable limits, every country’s population numbers are too high. We consume oil, coal, natural gas, drain aquifers, and cut down forests, to name just a few, faster than those renew. It does not matter that these resources are not directly eaten. It also does not matter that we used to live without using those resources. What matters is that without those resources, we could not feed all humans that are currently alive.

We must use oil, for example, to plant crops, fertilize, harvest, package, distribute, and store our food, and without oil no country can feed their numbers. This is the situation in every country; therefore every country is currently overpopulated.

We might be able to figure out ways to provide for the current population levels using only renewable means, and there are plenty of theoretical solutions involving wind, solar, and wave energy. If we manage to do this, we can proudly claim we have transitioned from overpopulated to not overpopulated. Until then, we are overpopulated and this means we must bring our numbers down.

What Should We Bring Our Numbers Down To?

This question does not need to be answered for many generations. We need to get our numbers down until we are not consuming resources faster than they renew. When we are in a situation where it is not obvious whether we are consuming resources faster than they renew, we can debate when we can allow a resumption of an average number of children that will maintain our population level. We will have to choose a level that is significantly below what can be sustained so that we have a cushion in the event of natural disasters that drop the sustainable limit.

The Realities of Averaging Births

If one group of people, defined by a geographic region, a family, or a religion, for example, have an average of 1 child and another of equal size average 3, the total average is two. We must recognize, however, that the group that averages 3 will grow and grow. The first group will shrink in size. The only way the group that averages 3 does not overpopulate the planet is if that group brings their average below two. The only way the first group does not go extinct, is if their average rises to at least two.

Everyone's descendants are an example of a group, and therefore they must not maintain an average above two. To put this in personal terms, your descendants must not maintain an average above two.

How Do I Ensure That I Do My Part? - T**he *TwoFourEight* Algorithm**

To do your part, you must not have more than 2 children. Count the number of grandchildren your parents have, and you should not have a child if that would create more than 4 grandchildren for your parents. Similarly, you should not have more children if this will create more than 8 great grandchildren for your grandparents.

This formula means that each family, siblings and cousins, takes responsibility for ensuring their numbers do not attempt to grow to infinity.

Population Pyramids

The student should recognize that the TwoFourEight algorithm, if done by everyone, would cause the population to decline immediately. If we limited ourselves to 2, or 1 as in the case in China, the population would continue to rise for some time before declining. This happens because the older generations did not stop at two, which means there are several times more young people than the number of grandparents and great grandparents.

When a population averages more than 2 children, the age distribution looks like a pyramid (Figure 1). When a population averages less than 2, it looks the same, but upside down (Figure 2).

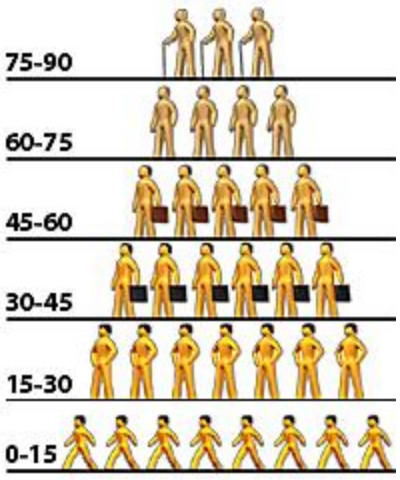

Figure 1

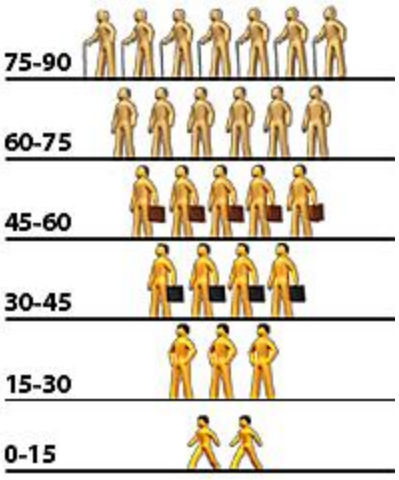

Figure 2

The upside down pyramid is the goal of all societies, because it means we are not heading towards the limit. An older population is a sign of success.

Note that in both situations the number of dependents is essentially identical. The number of people in their first 20 years of life plus the number in their last 20 years of life is the same in both situations. One has a lot more old people than young people. If it costs the same to support each person in the 2 different dependent age categories, there would be no difference between the 2 different age distributions. Note that it does not matter if the old person is living off his/her savings or depending on social security payments for his/her income, in both situations s/he is dependent on the labor of others.

What If We Have Too Few?

As explained above, if 4 billion people and all their descendants chose to average 1 child, their numbers would drop to 2 in about 800 years. If we adjust that slightly, we can say that if the current 7 billion people and all their descendants choose to average 1 child, then in approximately 800 years, humans would be extinct.

It might seem that we must avoid having too few children, and clearly as shown above, we must avoid having too many, but there's no harm with too few. There's nothing wrong with having no children. If every person on the planet decided to have no children from now on, in about 100 years the last humans would die. Humans would become extinct. It must be understood that no human will ever experience human extinction. No harm will have been done to another human because of this choice. The last few people alive might regret having had no children to take care of themselves, but they made this choice. In contrast, when we choose to have too many children, we inevitably bring our numbers to the limit, and that will cause children to die.

Conclusions

The general consensus of population experts is that the best way to keep the birth rate down is to replicate the conditions found in the developed countries, including improving women's rights, girl's education, access to birth control, and raising the standard of living of third world countries. However, we must do more. People need to be more educated about the population issues we face and how they can do their part in solving these issues. The facts in this curriculum need to become common knowledge, starting with young people at middle school age.

The first step in this process is for population experts to endorse and refine this curriculum.