A Classroom Activity to Illustrate the Demographic Transition

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Abstract: A discussion of the Demographic Transition is included in many Environmental Biology or Environmental Science classes. The Demographic Transition occurs as a nation becomes more urban and wealthy, and was widely observed in the twentieth century. The phenomenon includes decreasing family size (fewer children) across generations. In this classroom exercise, students provide numbers of children in past and future generations in their own families, and then the class analyzes the pooled data and hypothesizes why and how this change in human population biology occurs.

Keywords: human population, demographic transition, classroom investigation, inquiry, student data collection

Introduction

The human population is a topic of interest in most Environmental Biology, Environmental Science, and similar courses. Instructors have various classroom or laboratory activities available to explore population models (Moore and Holt 1973), including using computer simulation with packages like STELLA (Bice 2001, Bossel 1994, McKelvey 1995) or EXTEND (Odum and Odum 2000). Protocols using small organisms such as Duckweed (*Lemna*) (DeBuhr 1991, Jeffries 1991) or protistans (Glase and Zimmerman 1991) also exist. Many ecology classes examine survivorship curves or other aspects of human demography by collecting data in cemeteries (Flood and Horn 1991).

To appreciate human population dynamics, one must consider factors beyond population growth models. Although subject to biological constraints, human population biology is complicated by religious, cultural, economic, and other factors unknown in other organisms. For example, the population biology of a human society changes as it becomes more urban and industrial. The phenomenon of cultural changes resulting in decreased family size is known as the demographic transition. It is characterized by increased wealth, literacy, access to health care, and average lifespan. The phenomenon usually is phased, with initial improvements in infant mortality being followed by lowered birth rates and population sizes reaching an asymptote, and possibly even falling later. Sixteen popular environmental science textbooks published in the last five years all include a discussion of the demographic transition, sometimes comparing age distribution pyramids or fecundity among different countries.

Despite the recognized significance of the phenomenon, few teaching resources exist to help students explore the demographic transition. Bannister (1990) uses Egypt as a case study, comparing its population dynamic to that of Europe. Ulack (1978) presents alternative conceptual schemes for observations made in different world regions. Mulvihill (1981) describes an activity using population data from Latin America, including statistical analyses and an exploration of socioeconomic dynamics.

In this article I describe a classroom exercise in which students provide data about numbers of children (generation size) in their own families, and the data are immediately pooled and analyzed. The trend evident in the data stimulates a discussion of why women are bearing fewer children in recent generations in the United States and many other countries.

Methods

This activity takes place in the regular 50 minute class period. I enter data into a spreadsheet file and project them onto a screen, although simply making a table on the blackboard and filling in the data works as well. The spreadsheet can perform simple arithmetic to determine a normalized value (percent) across all generational data, and can also automatically generate a graph as data are entered. These functions make the data trend more apparent and can aid student comprehension. The spreadsheet file is available by request from the author.

When conducting the exercise, I begin by drawing or projecting the blank data table (Table 1) I explain that the activity is strictly voluntary and I assure students that participation has no effect on the course grade. I ask students to provide only reliable data; if a student is unsure about anything, s/he shouldn't respond.

I begin with the "Self" generation (i.e., the students in the room). I ask, "How many of you are an only child, without brothers or sisters?" I count the raised hands of students and the result goes in Column "1," row "self" in the table. I then ask for the number of students who have a single sibling and the count is placed in the same row under the column "2." Likewise I ask for the generation size of three, four, etc. Obviously the generation size must be at least one. I limit the maximum generation size to seven (grouping all answers greater than seven into this "7+" category). I have found from experience that very few students will have more than six siblings.

Likewise, the generation size will be at least one for the parents generation (i.e., the parents of the students), and the grandparents. I collect data for the parents, instructing students to raise both hands simultaneously if both parents have the same number of siblings. I do the same for grandparents, telling students to raise both hands even if they have three or four grandparents all having the same number of siblings; I simply point to a student and ask "How many?" and add to the running total. The case of step parents or half-siblings complicates the process; I tell students to answer for their own two biological parents and all their children (sib or half-sib). Each student could give two generation size responses for the Parents category, and four for Grandparents. When examining the data later, calculating the percent of responses in each size category normalizes the responses, and makes comparisons between generations much easier.

The "next" generation (bottom row of the table) is the last to be tallied, and is hypothetical: "How many children would you like to have, assuming your partner agreed?" My students are almost all 17-22 years old, and very few of them are parents. However most seemed to have considered the prospect of parenthood, and cheerfully respond. Here, the zero column is needed, as some students will indicate a desire to remain childless.

We examine the data immediately, and conduct a discussion during the class period. A 50-minute lecture period sometimes proves insufficient, so additional time may be needed in a subsequent class. The discussion is greatly improved if the data can be summed and converted to percentages in each generation, and a graph of those percentage data drawn immediately. Obviously the raw data have unequal sample sizes; each student might report a single number for Self and Next generations, two numbers for Parents, and four for Grandparents. Comparing percentages in each sibling size class, and average (mean) numbers of siblings across generations, is a more valid and illustrative approach.

Here, I present data from the Spring 2005 class of Introduction to Environmental Science (NASC 120) at Central College in Iowa. I tallied the data in class, and entered them into a Microsoft Excel spreadsheet to calculate percentages of families with each generation size. I also prepared weighted averages by multiplying the numbers of responses by the magnitude in each (i.e., generation size) and dividing these products by the total number of responses in each generation. Note that this weighted mean calculation actually underestimates the larger families, because families with seven or more children are all treated as if they had only seven.

To determine if differences in these generation sizes are significant, I performed a Chi-square contingency test using Microsoft Excel, comparing observed tallies with those expected if no generational difference exists. I consider $P \leq 0.05$ level to be statistically significant.

Results

Data from the Spring 2005 class of Introduction to Environmental Science (NASC 120) at Central College (n = 48 students) are shown in Table 2 and Figure 1. These data are typical, and clearly illustrate the demographic transition: family size (generation size) decreases over time. The Grandparents have the largest generation, averaging 4.6 children in each family. Parents have a mean of 4.1 children in the generation, and the students have a mean of 3.1 children per family. The students in the class will continue the trend, for if they act as they suggest, an average of 2.7 children will be born per family in the next generation. As noted in the Methods, these data actually underestimate the trend, since the frequencies of 7+ families decrease across time, and this category underestimates the true averages: families with eight, nine, or more children are weighted as if they had seven. Nevertheless, the results of the Chi-square contingency are highly significant (P<<0.0001).

In the eight semesters in which I have employed this exercise at Central College, we have always collected data illustrating the demographic transition. Students comment afterward that they enjoyed and appreciated the activity. Despite the potentially personal nature of the data, I have been sensitive about assuring students that they are free to decline participation, and I have never heard or read comments about the exercise causing discomfort.

In my class, I use an inquiry approach for this activity. We perform this exercise before I lecture or explain about the demographic transition. Seeing the data trend, students are curious and ask questions (and I ask questions to prompt them as well). Why are families smaller today than in the past? Did women not have access to contraception in the

Table 1. Blank table used to record data on generation (family) sizes. "Next" refers to number of children desired by the students themselves.

Generation	0	1	2	3	4	5	6	7+	total
Grandparents	--								
Parents	--								
Self	--								
Next?									

Table 2. Generation sizes reported by students in the NASC 120 class at Central College, Spring 2005.

Generation	0	1	2	3	4	5	6	7+	total
Grandparents	--	1	11	17	12	8	9	21	79
Parents	--	1	12	17	23	9	7	9	78
Self	--	0	14	15	7	1	2	1	40
Next?	1	0	19	14	4	2	0	0	40

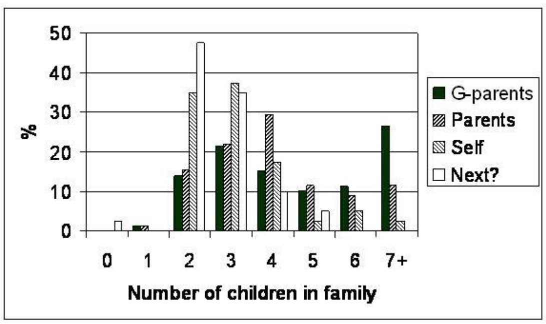

Figure 1. Graphic representation of the data in Table 2, normalized as percentages.

past? Are children more of a financial responsibility today? Have the social norms and expectations regarding families changed?

Discussion

Here, students indicate that their grandparents came from big families, averaging 4.6 children. Meanwhile, the students will approach zero population growth in their generation. I ask the students to speculate about reasons for this pattern. Class discussion generally centers on availability of effective contraception, and factors associated with the changing role of women, including postponing marriage and childbearing. In Iowa especially, the discussion can compare children as an economic resource (workers on the farm) versus children as a financial liability causing increased family expenditures.

Are Iowa students typical? Their recent ancestors may be more likely to live in a rural area than are the families of students elsewhere. However, even many city families are only two generations removed from an agrarian lifestyle, and the complex pattern of increased education for girls, more opportunities for women for employment outside the home, cultural norms, and other factors are probably present throughout any industrialized nation such as the United States.

I find this activity useful in teaching a critical environmental topic. By collecting data from the students in class, the topic is immediate and personal to them, and they are interested and invested in the outcome. By doing this activity first, before explaining the concepts, students are primed and curious to understand the phenomenon they've observed. I take advantage of this innate curiosity to practice scientific methodology in the classroom. We make observations, create a hypothesis, and test it against real data. For example, if the demographic transition occurs in nations as they industrialize, then it should be observed in European, but not African, nations. Data available in an environmental science textbook will support this assertion (see e.g., Cunningham et al. 2003).

I have always confined this activity to a single class period, but presumably this could be expanded. The data could be further analyzed and become the basis for a lab report. Students could interview people outside of class; reference population data from published sources such as the U.S. Census Bureau, or the United Nations; or design novel approaches to studying this phenomenon.

The demographic transition has been observed in numerous societies in the twentieth century. Some experts suggest that global human population growth is stabilizing, and will soon level off. If indeed this is the case, it will likely be the result of factors associated with the demographic transition.

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