Computers as tools that extend *and* constrain thinking

Activities based around Computer Models of Population Growth

(A class for ED610, written by Peter Taylor, version Nov. 9, 2001; updated Sep. 7 2017.[1])

Overall Learning objectives
Activities

1. Exercise to predict future populations on two islands

BREAK

2. Shaping the future of the two islands, a discussion
3. Identifying different kinds of analysis through the language used
4. Review of the lesson in light of learning objectives

Feel free to type your answers to questions directly into this file, make notes, paste in results from your spreadsheet work, and save the file at the end as a record of the class.

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1 For more details of this course see http://www.faculty.umb.edu/pjt/610-01Fp.html
This class is an attempt to provide instructions that keep students in a computer-assisted class on track, but allow for a mix of individual and co-operative work. Please email peter.taylor@umb.edu if you have comments, corrections, or suggested improvements.

2 Review basic spreadsheet commands. The commands needed are kept simple to model an approach that works verbally first before opening the spreadsheet. The goal here is to include people whose math-phobia might lead them to opt out if they started directly with a spreadsheet and formulas. In any case, advanced use of spreadsheets are not only to use of charts and jazzy layout, but to a thinking

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Overall Learning objectives

Review basic spreadsheet commands.[2]

Understand the idea that computer programs (including computer models) build in rules that restrict the user's options.[3]

Understand and apply guideline that ways should be explored to expose this restrictiveness.[4]

(View footnotes for introductory comments on each objective.)

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[2] Review basic spreadsheet commands. The commands needed are kept simple to model an approach that works verbally first before opening the spreadsheet. The goal here is to include people whose math-phobia might lead them to opt out if they started directly with a spreadsheet and formulas. In any case, advanced use of spreadsheets refers not only to use of charts and jazzy layout, but to thinking exercises that may require only simple formulas, such as activity 1.

[3] Understand the idea that computer programs (including computer models) build in rules that restrict the user's options. A spreadsheet can be used to extend our thinking not only by serving as a sophisticated calculator, but to allow us investigate scenarios, for example, to generate projections of future population figures. However, for a computer to do this, it has to be told how—to be programmed to follow certain rules. Sometimes, you're happy that someone else has done this programming and you don't need to think about it, e.g., when banks allow you to get money from an ATM machine 24/7. But other times you notice the constraints, e.g., when you want to withdraw $5, not $20.

[4] Understand and apply guideline that ways should be explored to expose this restrictiveness. The sequence of activities 1 to 3 are designed to expose the restrictiveness of lumping all individuals together, which is often done in population figures and in talking about society.

Activities
1. Exercise to predict future populations

(see footnote for overview[5] or proceed directly)

[5] <u>Overview of steps in activity 1.</u>

a. Work on paper to predict future populations in a simple case.

b. Get this checked by instructor who will put people in pairs of one person with some experience using spreadsheets plus one novice user.

Note: A more complex spreadsheet lesson can be attempted by more experienced people if you finish this activity early.

c. Novice converts the work on paper into spreadsheet form with assistance from the more experienced user.

d. Discussion in pairs about how to respond to the projections

e. Report verbally to the instructor

f. Novice creates more spreadsheet columns based on additional information (again with assistance from the more experienced user).

g. Discussion in pairs about how to respond to the new projections. This prepares the way for activity 2, which is done as a whole class.

a. Work on paper to predict future populations in a simple case

Demography is a science that takes data about birth and death rates, the age distribution of people in a country, and other factors and predicts (or projects) future trends.

This activity concerns two islands that have 10,000 hectares of land, 100 families, which means 10000/100 = 100 hectares/family.

(1 hectare = a square with a side of 100 meters = 2.54 acres)

The growth rate of each island is 2.5% per year, which translates to the population doubling every 28 years (which we'll call one generation).

Using mental arithmetic, fill in the second column, then fill in the third column.

Generation	Population	Area/family
	[no. of families]	[hectares]
0	100	100
1		
2		
3		
4		
5		

Move to part b on next page.

b. Show your calculations to the instructor who will check them and put you in pairs of one person with some experience using spreadsheets plus one novice user.

Note: Experienced users, please don't be frustrated at how basic this activity is. A more complex spreadsheet lesson can be attempted if you finish this activity early or after class to test yourself.

Move to part c on next page.

c. Novice converts the work on paper into spreadsheet form with assistance from the more experienced user.

Novice performs the following:
Find excel software on computer (using Find on the menu strips or command-F).
Start the program. Use the VIEW menu to make sure the formula bar is visible.
Return to this document by using the top right hand menu on a MAC or the strip (usually across the bottom) on Windows. There is no need to minimize any windows.
Practice switching among programs until you are comfortable.

Cut and paste the following table into the top left hand corner of a blank spreadsheet.

Generation	Population	Area/family
	[no. of 4 person families]	[hectares]
0	100	100
=A3+1	=B3*2	=C3/2

Check the answers in the cells A4, B4, C4. Do they make sense? Do you see how the formula (the expression starting with an = sign) works?

Select cell A4-C4, Copy.
Move to cell A5, and Paste
Notice the change in the formulas that appears in the formula window.

Select cell A4-C4 and again Copy.
Move to cell A5, hold down shift key, and move down to A16
Paste.
Check that the answers make sense.
If you have too many decimal places to read easily, reformat the column by selecting the whole column, and using the FORMAT menu to specify a fixed number of decimal places.

Move to part d on next page.

d. Discuss in pairs about how to respond to the projections.

The minimum area needed for a farming family to survive is 1 hectare. Using your projections to look ahead from now (generation 0) to the future:

What would you do on the basis of the projections?

What more might you like to know about the islands?
How might knowing this affect what you would plan to do?

Move to part e on next page.

e. Get the instructor's attention and report verbally on your answers to the questions

Move to part f on next page.

f. Novice creates more spreadsheet columns based on additional information (again with assistance from the more experienced user).

It turns out that farming land on one of the islands is not divided equally among the population. The richest 2% own 60% of the island; the poorest 70% own 2% of the island; and the 28% who are in the middle class own the remaining 38%.

Copy and paste the following into cells E1 to F3

Richest stratum	Middle stratum	Poorest stratum
[area/family]	[area/family]	[area/family]
3000	136	2.9

Invent and input a formula for E4 that gives the area per family after one generation.
If you are happy with the result,
Copy cell E4
Paste to E4-G16
Check that the answers make sense.
Print out your spreadsheet.

Move to part g on next page.

g. Discuss in pairs about how to respond to the new projections.
What would you do on the basis of the projections?

What more might you like to know about the island?
How might knowing this affect what you would plan to do?

Who are you when you answered these questions? Do you belong to one of the strata or are you an outsider? If an outsider, whose ear do you have on the island?

No need to report to the instructor. This prepares the way for activity 2, which is done as a whole class.

If you finish before everyone has finished you are welcome to begin working on another lesson using spreadsheets, downloadable from http://www.faculty.umb.edu/pjt/mortgage.doc.

2. Shaping the future of the two islands, a discussion

For this discussion the class is broken into four groups, each of which discusses the different options that people in their situation might take up and then reports back to the whole class.
Group 1 represents people in the rich stratum on the second island.
Group 2 represents people in the middle stratum on the second island.
Group 3 represents people in the poor stratum on the second island.
Group 4 represent people on the first island.

While you are waiting for others to finish activity 1 and for the instructor to allocate you to one of these groups, you may record ideas about the options available to the different groups in the table below.

Rich stratum	Middle stratum	Poor stratum	Island 1

Additional notes after reports back to the whole class:

3. Identifying different kinds of analysis through the language used

The previous activities have indicated that the implications of the population growth change markedly if one shifts from a model in which projections of the future treat everyone as an equivalent unit to a model in which inequality among units is taken into account. Moreover, when those different, unequal groups respond to the situation and the actions of the other groups, the implications change even further. One way to stay alert to whether you are being presented a "uniform" analysis even in cases in which there is no computer model involved is to watch the language used to describe the problem and solutions. There are two variants.

"Moral" variant—Everyone needs to change their basic values and behavior to prevent the future problem (or solve an existing crisis)	"Technocratic" variant—Everyone needs to follow the solutions that the technical experts have identified as needed to prevent the future problem (or solve an existing crisis)
Language used—We, our, humans, humanity, our species, will, purpose, commitment,.. + interchanging of individual and whole group, e.g., "<u>mankind</u> can postpone initiating deliberate control of <u>his</u> growth"	Language used—control, manage, ...has to be shifted + emphasis on scientific analysis

Both variants portray the problem as one of biological or physical limits (e.g., running out of food or space). They tend to grab our attention by stressing the severity of the problem and indicate that it is in everyone's interest to follow their guidance or leadership.

In contrast, when the units are unequal and linked together through economic/ social/ political dynamics the limits are social (in various ways) and the language is more complicated because there is no one size fits all response.

Read the following passage from an early account (in 1985) of global climate change. Identify words or phrases that correspond to a moral way of thinking, a technocratic way of thinking, or both.

> We are moving into a period of chronic, global, and extremely complex syndromes of ecological and economic interdependence. These emerging syndromes threaten to constrain and even reverse progress in human development. They will be manageable--if at all--only with a commitment of resources and consistency of purpose that transcends normal cycles and boundaries of scientific research and political action.[6]

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[6] Clark, W. C. and C. S. Holling (1985). "Sustainable development of the biosphere: Human actvities and global change," in T. F. Malone and J. G. Roederer (Eds.), <u>Global Change</u>. Cambridge: Cambridge University Press, 474-490.

When you've tried the exercise yourself, see footnote for color-coded analysis of the quote.[7]

Now read Meffe et al. (1993)[8] on human population control. Identify one or more points where the language used or ideas presented fits the uniform units analysis and, if you can find one, the unequal dynamics analysis. Discuss what you find with your partner.

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[7] Green = moral; pink = technocratic; blue = both; red = seriousness of problem

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These emerging syndromes threaten to constrain and even reverse progress in human development.

They will be manageable--if at all--only with a commitment of resources and consistency of purpose that transcends normal cycles and boundaries of scientific research and political action."

William Clark and C. S. Holling (1985)

[8] Gary K. Meffe, Anne H. Ehrlich and David Ehrenfeld. "Human population control: The missing agenda." Conservation Biology 7, no.1 (1993): 1-3

4. Review lesson in light of learning objectives:

Review basic spreadsheet commands.

Understand the idea that computer programs (including computer models) build in rules that restrict the user's options.

Understand and apply guideline that ways should be explored to expose this restrictiveness.

Explain in your own words how the activities related to each of these objectives.

The optional after-class reading: Taylor, "How do we know" does not address the use of spreadsheets in teaching, but it does speak to the philosophy behind the other two learning objectives. For some excerpts relevant to activities 3 and 4, see footnote.[9]

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[9] Some excerpts relevant to activities 3 and 4.

Consider two hypothetical countries. Country A has a relatively equal land distribution; Country B has a typical 1970s Central American land distribution: 2% of the people own 60% of the land; 70% own 2%. In other respects these countries are similar: they have the same amount of arable land, the same population, the same level of capital availability and scientific capacity, and the same population growth rate, say, 3%. If we follow through the calculations of rates of population growth, food production increase, levels of poverty, and the like, we find that five generations before anyone is malnourished in country A, all of the poorest 70% in Country B already are. Food shortages linked to inequity in land distribution would be the likely level at which these poor people, and by implication most of the world's population, would first experience what others call "population pressure." In the [Limits to Growth (LTG) computer] model global aggregation of the world's population and resources obscured the fact that crises will not emerge according to a strictly global logic, much less in any global form as such. The spatial disaggregation in Mankind at the Turning Point does not resolve this issue. Land-starved peasants share nations, regions, and villages with their creditors, landlords and employers. The socio-political responses of the peasants and, by extension, the ramifications of such local responses through national, regional, and international political and economic linkages, will be (and already have been) qualitatively different from those highlighted by the LTG.

This simple counter example to global modeling does not tell us how to analyze the politics within localities, nations, regions, or the world, politics in which people contribute differentially to environmental problems. My point here is simply to highlight the politics of inequality excluded by the science of [system dynamics (SD)] in its analysis of global limits to growth. The moral and technocratic emphasis is by no means a unique characteristic of the LTG study. My critique of the LTG's science-politics can be extended to the current globalization of environmental discourse. Before doing so, let me first say a little more about the moral-technocratic alliance that such discourse generally presupposes.

In technocratic formulations, objective, scientific, and (typically) quantitative analyses are employed to identify the policies that society (or, in the case of the LTG, humanity) needs in order to restore order or ensure its sustainability or survival--policies to which individuals, citizens, and countries would then submit. In the LTG these policies are deduced from the model structure, which is held to reveal a dynamic that the ordinary citizen, politician, or businessperson would not have recognized or specified. Moral formulations, in contrast, try to avoid coercion and rely on each individual making the change needed to maintain valued social or natural qualities of life. Yet, in many senses the moral and technocratic are allied. Both invoke the severity of the crisis and threat to our social order to command our attention. The solutions appeal to <u>common, undifferentiated</u> interests as a corrective to scientifically-ignorant or corrupt, self-serving or naive governance. Moreover, appearances notwithstanding, special places in the proposed social transformations are reserved for their exponents--the technocrat as analyst/policy advisor; the moralist as guide, educator or leader.

Revealingly, the LTG report combined at numerous junctures managerial language and moral recruitment (emphases mine): "Until the underlying structures of our socio-economic systems are thoroughly analyzed, they cannot be <u>managed</u> effectively"; "The economic preferences of society <u>are [to be] shifted</u> more toward services"; "We cannot say with certainty how much longer <u>mankind</u> can postpone initiating deliberate control of <u>his</u> growth"; "The two missing ingredients are a realistic, long-term <u>goal</u> that can guide mankind... and the human <u>will</u> to achieve that goal." In short, according to the LTG team, the global society needs management to achieve control; mankind as a whole, like an individual man, needs a goal and a will to change.