Teaching Notes

Wrap-up of the People Count Stories

Implementation

The following projects or investigations are intended to be explored by students independently or in small groups. The directions for students in this wrap-up are less specific than many of the problems set-up in previous lessons. Consider these problems as independent or small group projects to conclude students' work with this module. You might consider, however, additional investigations involving other countries or other types of projection models. Projection models are extensively used in financial applications, as well as in estimating the counts of various endangered animals (for example, bees), estimating and analyzing the level of carbon emissions in the atmosphere, estimating the consumption of fresh water, etc. Designing models that analyze future outcomes represent one of the most important applications of mathematics in disciplines that rely on an understanding of the structures of mathematics (such as ratios, proportions, sequences, units).

Projects or Investigations

Consider completing one or more of the following projects to wrap-up your work with this module. Access to the spreadsheet files identified in the description of each project is needed to complete the project. You are expected to change the factors of the designated spreadsheet file to answer the questions or problems. A written summary of what you changed and why you made those changes is also expected.

Project 1: Estimating the Least Count of Immigration

Spreadsheet file needed to complete this project: USA Recursive Model

How many people during each of the 5-year periods from 2020 to 2050 are counted as immigrants if the recursive model is used to estimate future counts? Use the recursive model as designed in the spreadsheet ***USA Recursive Model*** to derive estimates of the least count of immigrants for each of the 5-years from 2020 to 2050. For example, what is an estimate of the least number of immigrants at the start of 2020 over the past 5 years if the recursive model is used to estimate future counts? In the same way, what is an estimate of the least number of immigrants at the start of 2025? 2030? … 2050?

Write a summary of how you revised the model and what were the estimates you obtained. Consider developing graphs to display the values over the 5-year intervals.

Any population factor greater than 1 indicates more people were added to the connecting age groups The only way more people could be added during a 5-year period is by immigration.

Although immigration also happened in connecting age groups with a population factor less than 1 (and also in the 0 – 4 years old age group), the counts in those age groups cannot be analyzed using the recursive model to estimate the counts of immigrants.

The best way to estimate the least count would be to add the increases in each of the connecting age groups that grew in count. This could be done by setting each population factor greater than 1 to the value of 1 (or slightly less). The resulting total population for that 5-year period would not include the increases in the age groups that had more people added by immigration. Compare the population totals obtained by revising the population factors to the totals obtained with no changes to the population factors. Encourage students to explain the changes they propose and their interpretation of the changes due to immigration.

The following table is provided to help evaluate students' estimates:
(Estimates are represented in millions of people)

	2020	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
No changes to population factors	331.78	341.87	350.87	358.55	364.94	370.45	375.67
Changes to population factors	328.32	334.74	339.50	343.37	345.15	345.83	345.89
Difference (an estimate of the least count of immigrants)	3.46	7.17	11.37	15.18	19.79	24.62	29.78

Project 2: Another Evaluation of the Recursive Model

Handout needed to complete this project: Handout 12: *Looking Back to Evaluate the Recursive Model (United States)*
Spreadsheet file needed to complete this project: Wrap-up Model.xlsx

Lesson 16 evaluated the recursive model by comparing (and revising) the projected estimates to the projections of the Census Bureau. The evaluation of which model is more accurate, however, requires waiting until 2050 at which point a census will be conducted.

Is there another way to evaluate the recursive model that would not require waiting until 2050? What if we used past counts provided by the Census Bureau (1980 and 1985), enter these counts in the recursive model, and then compare the projected results from the recursive model to the actual census counts reported in the census of 2010 and 2015?

The above plan provides an evaluation of the recursive model by looking back. Handout 12 provides the US Census counts (with estimates rounded off as indicated) for 1980 and 1985. The Excel spreadsheet **Wrap-up Model.xlsx** provides you the recursive model with columns set-up for the past. Each of these files are tools to assist you with the goals of this project. Enter the data from Handout 12 into the spreadsheet file to derive estimates for the US in 2010 and 2015. Are the estimates a good match to what was reported by the Census Bureau that summarized the census in 2010?

Write a summary that compares the estimates from the recursive model estimates to the reported Census counts. Indicate in your summary what you think happened in the country during those years that required changing the recursive model to match its outcomes to the reported census of 2010 and 2015. (For example, did more people die or leave the country during this time than the model projected? Were there more immigrants than anticipated by the model?)

*Provide students the spreadsheet file **Wrap-up Model**. In this spreadsheet, students will enter the 1980 and 1985 population counts provided with Handout 12. The spreadsheet will derive the population factors, the foundation factor, the age group counts, and the total population counts. Students are expected to compare the totals for 2010 and 2015 of the recursive model (starting with the year 1980) and the counts reported by the US Census Bureau.*

The following summary is provided to guide students' work:

	2010	2015
Using the **Wrap-up Model**	**301.68**	**312.94**
The Census values	**309.35**	**320.91**

The summary students develop should indicate that the Census values (obtained from an actual census) were greater than the recursive model's projections. The population factors derived from 2010 to 2015 are greater than the population factors from 1980 to 1985. The greater factors indicate there was more immigration, along with possibly people living longer prior to the 2010 and 2015 counts. Students should also note, however, that there is a difference in the foundation factors. The foundation factor for 1985 indicates that 0.075 or 7.5% of the population was 0 – 4 years old. The foundation factor for 2015 was 6.2%. Therefore, the increased counts in the intervening years are primarily a result of more immigration.

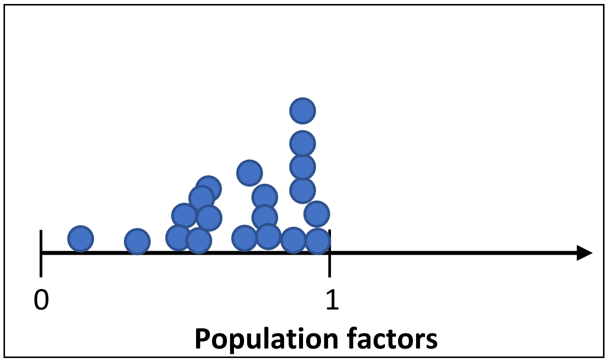
Project 3: Population Factors are not the Whole Story of a Country

Spreadsheet file needed to complete this project:

USA Recursive Model.xlsx

Two problems were presented in Lesson 10 that can be investigated further with the recursive model and the spreadsheet files. The first problem was the following:

1. Consider the following dot plot of the population factors of a fictitious country:



   a. What is the dominant explanation of change in the connecting age groups for a country represented by the above dot plot?

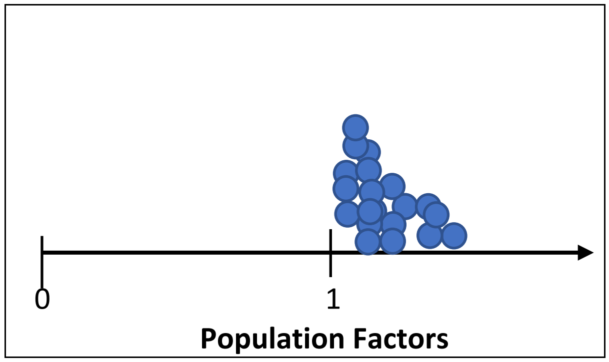
   b. Do you think it is possible for a country with the above population factors to have an increase in its total population during a 5-year period? Explain.

The dot plot indicates that all of the population factors derived in the recursive model were less than 1. Could the total population of country with the above population factors still grow over time? Design a fictitious country or obtain data for a real country to answer that question using the spreadsheet.

A country of this type was actually observed with the Kenya population. The large foundation factor (indicating a high birth rate) resulted in a large count of 0 – 4 years old for each of the 5-year intervals. The count was greater than the loss due to death or moving out of the country. If students create a fictitious country, counts that are more concentrated in the younger age groups and have all population factors less than 1 will emerge as examples. Remind students, however, that the more recent population summaries for Kenya indicated decreased counts in the younger age groups. As a result, Kenya's changes in the future are projected by the Census model to be different than the estimated counts using the recursive model.

The second problem in that lesson was the following:

2. Consider the following dot plot of the population factors for another fictitious country:



   a. What is the dominant explanation of change in the connecting age groups for the above dot plot?

   b. Do you think it is possible for a country with the above population factors to have a decrease in its total population during a 5-year period? Explain.

The dot plot for the second country indicates that all of the population factors derived were greater than 1. Could the total population of a country with the above population factors decline over time? Design a fictitious country or obtain data for a real country to answer that question using the spreadsheet file.

Write a report that indicates if you think countries could exist for each problem, and if yes, what were the counts and factors you used in setting up the population in these countries.

This scenario is more difficult to design, however, it is possible. A fictitious country in which the largest count of people are in the older age groups (with population factors slightly greater than 1) and a small foundation factor will result over time with a declining population. The loss of the older age groups to death at 100+ (as the design of the recursive model does not go beyond that age group) results in more people lost than gained by the other age groups and a small foundation factor. There is currently no country of this type, however, Japan's population is close.