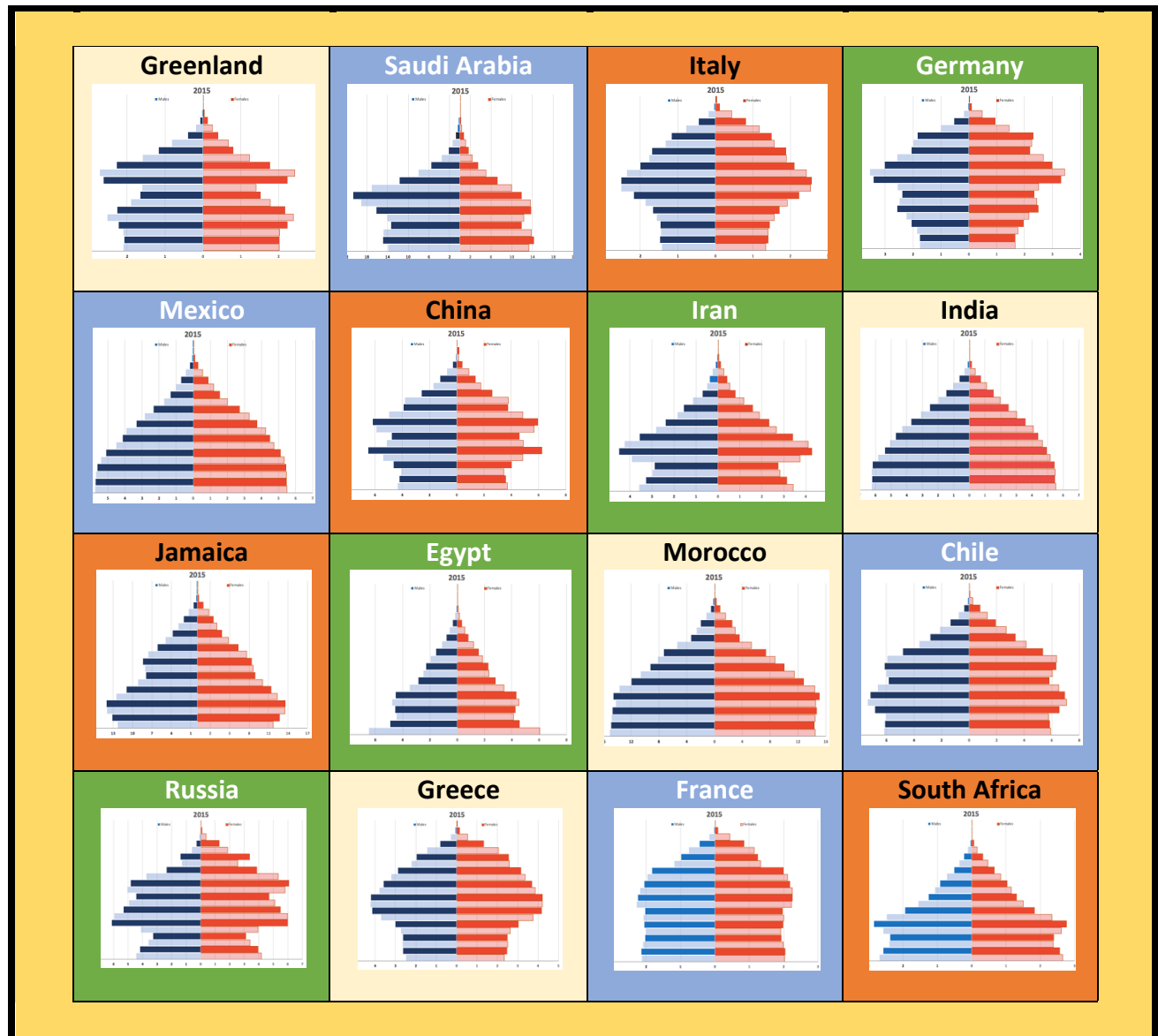


# People Count!

## (And Their Data Stories)

Henry Kranendonk  
Marquette University



Henry's Quilt of Countries

Data Stories  
Modeling with Data

# People Count! and the stories of ...

Kristin  
Generation X

Abbey  
The Millennial

Adeline  
Generation ?



\* Henry's Quilt

Parents  
Baby Boomers

And generations yet  
to be named

The population data used in this module were extracted from the **International Data Base (IDB)** website <https://www.census.gov/programs-surveys/international-programs/about/idb.html>. This website is maintained by the United States Census Bureau. Data used in this module were obtained from the **IDB** in 2018 - 2020. Population estimates used in the module may be different than what is posted on the website due to periodic updates and revisions. The author is indebted to the United States Census Bureau for providing this valuable data and allowing it to be used in this module.

***People Count! (and their data stories)*** Copyright © 2020

These lessons are free for personal use only and may not be reproduced or sold. When sharing with others, be sure to acknowledge the American Statistical Association as copyright holder.

## Acknowledgements

Let me start by thanking my former students at Rufus King High School in Milwaukee, Wisconsin who piloted the first several lessons of this module. Students in my International Baccalaureate (IB) Math Studies courses as well as students in my computer science courses were involved in working through problems in the early stages of developing several lessons.

I thank Gail Burrill for introducing me to population pyramid graphs and for her encouragement and support through the years. I thank David Ebert, a friend and fellow mathematics teacher, for his feedback and writing the **Foreword**. I also thank the early reviewers, namely Donald Cramer, Kevin McLeod, Mary Mooney, Michael Steele, Melissa Manley, and Steven Gorski. I especially thank Johnny Lott for reviewing the first draft and encouraging me to continue writing this module at a time I was not sure if it would have any value to students and teachers.

I thank my family for putting up with me while trying to weave this material together. In particular, I thank my wife Jean Kranendonk. I also thank my daughters Laura DeCicco, Kristin Moala, and Abbey Kranendonk, and my grandchildren Adeline, Paul, and Dominic DeCicco for allowing me to use their names as part of the data stories.

I would especially like to thank my daughter Kristin Moala for creating the illustrations that are included in several of the lessons and the data stories that include her name, and to my son-in-law Peter Moala for editing an early edition.

Finally, I would like to thank the Marquette University Upward Bound program. In particular, I thank Steven Robertson, Director of the Marquette University Upward Bound program, for providing the opportunity to pilot this module with high school students enrolled in the 2018 summer program. I also thank my Marquette University students for completing several lessons as part of the course work and for their feedback they provided as part of their evaluations.

I am especially grateful to Rebecca Nichols, Director of Education for the American Statistical Association, for her direction and encouragement during the process of getting this published in ***Statistics Teacher***. I am indebted to the NCTM/ASA Joint Committee on Curriculum in Statistics and Probability for organizing the review process and encouraging me to complete the module. I especially thank the Joint Committee for arranging an invaluable review by James Molyneux and Suyen Moncada Machado. James and Suyen extensively worked through the problems and provided critical suggestions and edits to an early draft. Their final words of encouragement after all of their work was a major inspiration to finish this module.

Finally, allow me to dedicate this module to the memory of my infant son, Jeffrey Scott Kranendonk. "There was too little time."

Thanks again to everyone involved in this project.

Henry Kranendonk

2020

## Foreword

I first met Henry Kranendonk at a workshop nearly twenty years ago. I was a young early career teacher, and Henry was a veteran mathematics teacher. That workshop was my first introduction to the population pyramid graphs that are featured in *People Count*. I was, and continue to be, astounded by the beautiful simplicity of the graphs, and how such a simple graph can tell such a complex story. Henry introduced me to a new way of thinking about the visualization and analysis of data.

The National Council of Teachers of Mathematics' book, *Catalyzing Change in High School Mathematics*, states that high school mathematics empowers students to expand professional opportunity, understand and critique the world, and experience wonder, joy, and beauty. Most high school mathematics and statistics textbooks and curricula do a good job expanding our students' professional opportunities, but fall short in bringing our students to understand and critique the world. Very few materials lead our students to experience wonder, joy, and beauty. *People Count* fills that void by guiding our students to an understanding of world population issues through the use of beautiful population pyramid graphs.

Too often, unfortunately, what is presented as "mathematical modeling" in many textbooks and curricula is either low on actual mathematics, or low on real-world connections. *People Count* is a great example of real, important data analysis that involves a high amount of mathematical rigor. Throughout the book, the knowledge and skills required by students builds on their experience in each successive unit, and each unit is another piece in the story of real people identified through their stories. The narratives present the mathematics as a student-centered story to be explored rather than a teacher-centered set of problems to be completed.

The book you have in front of you is the culmination of a career dedicated to sharing the simple complexity of population pyramid graphs with hundreds of students and teachers. It is a valuable addition to the field, and offers a compelling example of the investigative process of statistical problem solving called for in the American Statistical Association's *Guidelines for Assessment and Instruction in Statistics Education* (2007) or **GAISE**. Thank you, Henry, for bringing this material to hundreds of your students; and thank you, through this book, for sharing this material with thousands of students across the world.

David Ebert  
High School Mathematics Teacher  
Member, NCTM Board of Directors, 2016-2020

# People Count! (And Their Data Stories)

## Table of Contents Student Edition

### Introduction to Module

### Unit 1: A Country's Shape

Introduction.....	3
Lesson 1: <i>The United States - A Lower Middle-Layered Country</i> .....	4
Lesson 2: <i>Kenya – A Bottom-Layered Country</i> .....	13
Lesson 3: <i>Japan – An Upper Middle-Layered Country</i> .....	19
Lesson 4: <i>The Center and Spread of a Country's Shape</i> .....	26
Lesson 5: <i>My Country</i> .....	42

### Unit 2: Looking Back

Introduction.....	49
Lesson 6: <i>Looking Back at the Shapes of the United States</i> .....	50
Lesson 7: <i>Looking Back at the Shapes of Kenya and Japan and My Country</i> .....	60

### Unit 3: Looking Forward

Introduction.....	68
Lesson 8: <i>Looking Forward with an Arithmetic Sequence and a Linear Model</i> .....	69
Lesson 9: <i>Looking Forward with a Geometric Sequence and an Exponential Model</i> .....	78
Lesson 10: <i>Looking Forward with a Recursive Model</i> .....	86
Lesson 11: <i>The Recursive Model and Falling Dominos</i> .....	92
Lesson 12: <i>Completing the Recursive Model with the Foundation Layer</i> .....	102
Lesson 13: <i>“The More Things Change, the More Things Stay the Same”</i> .....	109
Lesson 14: <i>Kenya, Japan, and the United States – Summing it Up</i> .....	116

### Unit 4: “What if ...?”

Introduction.....	124
Lesson 15: <i>“What if ...?” Scenarios</i> .....	125
Lesson 16: <i>The US Census Models and the Recursive Model</i> .....	142
Wrap-up of the People Count Stories.....	158

# People Count! (And Their Data Stories)

## Table of Contents

Teacher Edition

Acknowledgements

Foreword

Overview of Module.....	iii
Ideas for Using this Module.....	iv
Managing Real-World Mathematics Problems.....	v
The Modeling Continuum.....	vi
Supporting Standards of Mathematics.....	x
Writing a Data Story.....	xiii
Implementation Guidelines.....	xiv
Introduction to Module.....	1
Unit 1: A Country's Shape	
Introduction.....	3
Lesson 1: <i>The United States - A Lower Middle-Layered Country</i> .....	4
Lesson 2: <i>Kenya – A Bottom-Layered Country</i> .....	15
Lesson 3: <i>Japan – An Upper Middle-Layered Country</i> .....	23
Lesson 4: <i>The Center and Spread of a Country's Shape</i> .....	31
Lesson 5: <i>My Country</i> .....	48
Unit 2: Looking Back	
Introduction.....	55
Lesson 6: <i>Looking Back at the Shapes of the United States</i> .....	56
Lesson 7: <i>Looking Back at the Shapes of Kenya and Japan and My Country</i> .....	68
Unit 3: Looking Forward	
Introduction.....	81
Lesson 8: <i>Looking Forward with an Arithmetic Sequence and a Linear Model</i> .....	82
Lesson 9: <i>Looking Forward with a Geometric Sequence and an Exponential Model</i> .....	94
Lesson 10: <i>Looking Forward with a Recursive Model</i> .....	105
Lesson 11: <i>The Recursive Model and Falling Dominos</i> .....	116
Lesson 12: <i>Completing the Recursive Model with the Foundation Layer</i> .....	128
Lesson 13: <i>"The More Things Change, the More Things Stay the Same"</i> .....	138
Lesson 14: <i>Kenya, Japan, and the United States – Summing it Up</i> .....	149
Unit 4: "What if ...?"	
Introduction.....	160
Lesson 15: <i>"What if ...?" Scenarios</i> .....	161
Lesson 16: <i>The US Census Models and the Recursive Model</i> .....	169
Wrap-up of the People Count Stories.....	188