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## Author's Reflections on *Making Sense of Numbers: Quantitative Reasoning for Social Research*

Jane E. Miller

*Rutgers, The State University of New Jersey*, jem@rutgers.edu

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## Author's Reflections on *Making Sense of Numbers: Quantitative Reasoning for Social Research*

### Abstract

Miller, Jane E. 2021. *Making Sense of Numbers: Quantitative Reasoning for Social Research*. (Los Angeles: SAGE Publications) 608 pp. ISBN 978-1544355597.

This article introduces and provides an excerpt from *Making Sense of Numbers: Quantitative Reasoning for Social Research*, published by Sage. The book explains and illustrates how making sense of numbers involves integrating concepts and skills from mathematics, statistics, study design, and communications, along with information about the specific topic and context under study. It teaches how to avoid making common errors of logic, calculation, and interpretation by introducing a systematic approach and a healthy dose of skepticism to understanding and applying numbers to social research and everyday tasks.

### Keywords

quantitative reasoning; research methods; statistics

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### Cover Page Footnote

Jane Miller is a Professor at the School of Planning and Public Policy at Rutgers, The State University of New Jersey. She is the author of *The Chicago Guide to Writing about Numbers*, and *The Chicago Guide to Writing about Multivariate Analysis*.

## Introduction

I came to write *Making Sense of Numbers (MS#)* after decades of happily applying numbers to a wide range of real-world questions. As a kid, I made up my own math problems without thinking of them as such: graphing time-series of crocus colors in my backyard, creating histograms of M&M colors from my bag lunches, and learning how to fill out baseball box scores while attending Cubs games with my uncle. Cooking, carpentry, and other hobbies provided me with additional opportunities to see the usefulness of numbers. As part of my formal education, I liked seeing how numbers were used to answer questions for biology lab reports in high school, my economics thesis in college, my doctoral and post-doctoral work in demography, and my health services research as I worked my way up the tenure ladder.

What I didn't recognize until well into my professorial career was just how much I had absorbed from these formal and informal learning situations about the process of making sense of numbers: Not only the critical thinking skills but also the confidence to teach myself about unfamiliar topics and new kinds of quantitative tasks. While teaching epidemiology, research methods, and other quantitative courses, I have seen repeatedly that many of my students had very different experiences with, and attitudes about, quantitative information: They found numbers to be some combination of boring, irrelevant, and terrifying. In many cases, they couldn't recognize when a numeric value made no sense for the task at hand. Since elementary school, they had learned to work with numbers by memorizing a bunch of formulas without understanding them. Many of them had no faith whatsoever in their ability to "do math" and sought to escape from quantitative work as soon as possible, seeing little if any connection between numbers and the things they needed or wanted to do.

Further evidence of math phobia and innumeracy arose as I taught workshops based on my book *The Chicago Guide to Writing about Numbers* (Miller 2015). It became apparent that many participants in those workshops had difficulty communicating numeric information in large part because they didn't understand where it came from or what it meant. Often, they didn't even realize that they were misunderstanding the underlying concepts or were producing and reporting values that made no sense. I observed these issues not only among undergraduates but among more advanced students and seasoned professionals and among both academics and people in applied fields such as public policy or health. I began to hear from faculty in various fields and from different universities that they were using *Writing about Numbers* to teach quantitative reasoning and numeracy because they found my explanations of numeric concepts to be clear and relatable

and my instructional devices—such as annotated examples—to be effective ways of illustrating the ideas and skills.

## **Objectives of *Making Sense of Numbers***

*MS#* is my effort to provide a comprehensive introduction to the needed research methods, design and statistical concepts, quantitative reasoning skills, and communications techniques and to integrate them into a cohesive whole so that students can learn to approach numbers with more confidence and mastery. The book explicitly addresses the fact that making sense of numbers involves far more than just understanding the math and statistics. It also requires an understanding of issues related to study design, data collection and analysis, the ability to communicate numeric facts and patterns, and a solid grounding in the specific topic under study.

A key objective of *MS#* is teaching students how to avoid making common errors of logic, calculation, and interpretation by introducing a systematic approach and a healthy dose of skepticism to understanding and applying the numbers they encounter. The following true story underscores how crucial it is to learn how to interpret the numeric values that relate to a particular topic, units, and setting before working with those numbers. A young researcher was analyzing infant birth weight using survey data from a developing country from the year 2002, which she had downloaded from a website but hadn't learned much about before she started analyzing it. In the sample of cases she was studying, birth weight values ranged up to 9,999 with an average of about 8,000. Had she taken the time to look up the expected range of values for that concept (birth weight) and units (grams), she would have immediately seen a red flag because 9,999 grams is roughly 22 lbs.—a typical weight for a 1-year-old child, not a newborn baby!

In addition, it turned out that the birth weight question was *not* asked about children who were 5 to 17 years old at the time of the survey, so in the electronic data set, kids those ages were given the value “9999” as shorthand to indicate that birth weight information was missing for them. Once the student researcher learned what those 9999s meant, she had to redo all the analyses for her final paper at the last minute, excluding the cases with missing values so that the remaining numbers could be interpreted as actual birth weight in grams.

That story illustrates how an understanding of several different facets of topic, units, study design (skip patterns), data collection (question wording), and data analysis is essential for students to be able to differentiate between plausible and implausible numeric values as they conduct and apply research. *MS#* will help your students avoid those kinds of mistakes and all that stress by teaching them the right questions to ask about the numbers for their topic and data *before and during* the research process.

Even if students aren't thinking of research as a major focus of their careers—what I refer to as “Research with a Capital R”—they will need to use numeric facts in various ways as they go about their daily lives, act as informed citizens, and perform the functions of their jobs. It takes only a quick scan of today's media to see just how many aspects of life require students to understand and apply numeric information. For instance, a newspaper might feature cover stories on election results, COVID-19 rates, crime, and disparities in education, each of which presents and discusses numeric facts about different places, groups, dates, and sources of information. Other sections of that day's paper might include articles on the stock market, a few scientific topics, employment, housing, the environment, technology, several sports, the weather, and many other topics that involve numeric facts and patterns. That is a lot of different topics (and numbers) for students to become familiar with; moreover, new topics arise all the time.

## Contents and organization of *MS#*

In *MS#*, I provide a comprehensive guide to applying research methods concepts and quantitative reasoning skills to finding, analyzing, interpreting, and communicating numeric information. I organize much of the book using the W's as a checklist for identifying the types of information needed to make sense of numbers from quantitative research. “What”—otherwise known as the topic—is a crucial piece of information, because a numeric value that is completely reasonable for one topic might be utterly ridiculous for another. The context of a study (which encompasses “when,” “where,” and “who”/“which” cases are included) is also essential, because a number that fits one time, place, or group can be far too high or too low for a different time, place, or group.

What at first appears to be a single “honorary W”—“how”—turns out to have several dimensions, including the approach used to measure the concept of interest; the type of study design, sampling methods, and sources of the data; the aspects of study design that affect whether a relationship between two variables can be interpreted as cause and effect; and the mathematical and statistical methods used to analyze the data. Another “honorary W”—“how many” (sample size)—also has implications for making sense of numeric estimates based on samples. Each of those aspects of “how” the research was conducted affects the ways that the resulting numbers can be interpreted and applied.

Three other chapters are devoted to communicating about numbers using tables, charts and other visualizations, and prose, with the aim of helping students learn to be both effective consumers and producers of commonly-used tools for conveying numeric information. Throughout, I provide citations to recommended textbooks that go into more depth about statistics (Salkind 2016; Utts and Heckard

2014), research methods and study design (Chambliss and Schutt 2019), charts and visualizations (Evergreen 2019), and written or spoken prose (Miller 2015).

## Excerpt from *Making Sense of Numbers: Quantitative Reasoning for Social Research*<sup>1</sup>

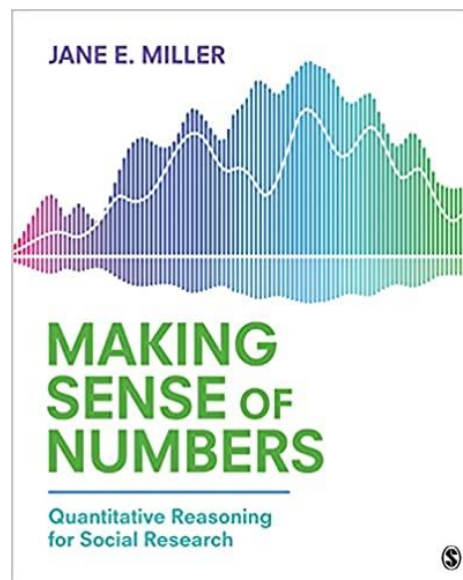
*The following excerpt from Chapter 1 of MS# illustrates how I use a wide range of everyday topics to introduce ideas to be covered in more depth later in the book, where I define specific concepts, introduce relevant skills, and apply them to more formal research topics and tasks. That way, the students start by reading about a few basic principles for making sense of numbers in ways that aren't too daunting, to help dispel (or at least reduce!) their anxiety about math and research methods.*

A value or difference between values that is “big” for one topic, context (place, time, and group), and type of units might be “small” for another topic, context, or units.

- A value of 10,000 is possible if counting the number of people in a town but impossible as the height of a person in inches.
- A final score of 105 to 98 makes sense for basketball but is way too high for ice hockey. On the other hand, a score of 3 to 0 would be a pretty typical score for a hockey game, but outrageously low for any but a preschool basketball game. And it is a rout when an international football (soccer) team wins by 3 points, but a close game when a U.S. football team wins by the same margin.

The type of measure, calculation, or contrast also determines which numeric values do (and do *not*) make sense.

- Certain numeric measures can only take on positive values or can only be counted in whole numbers. For example, the number of students in your class cannot be negative or include fractions of people.



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- On the other hand, the *change* in number of students between the beginning and end of the school year could be negative if some people dropped out or moved away, and *average* class size at your school could include decimal places (e.g., 24.7 students per class).

Making sense of numbers also involves knowing whether higher values represent an improvement or decline in whatever you are measuring.

- For some things, a higher score is better. For example, a higher credit rating will help you qualify for credit cards, more favorable interest rates on loans, and other financial advantages.
- For other topics, a lower score is what you're aiming for. For instance, you want to *minimize* points added to your driver's license because more points mean higher car insurance premiums and greater chances of your driving privileges being revoked.

For many topics and research questions, there are numeric cutoffs and benchmarks that help us interpret what a particular numeric value means for that topic and units. Numeric goals, thresholds, and standards can also help convey whether a particular numeric value is high or low, favorable or unfavorable. You will learn more about cutoffs, thresholds, and target values in Chapter 8.

Example: The threshold 32° F is the freezing point of water.

*Although that **cutoff** is highly relevant for topics related to physical properties of water, there probably aren't many other **topics** for which the value "32" is relevant for defining a concept or differentiating between meaningfully different categories. Besides, 32 °C (Celsius) = 89 °F (Fahrenheit), and the freezing point of water is 0° C, so clearly knowing the **units** matters as well.*

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## References

Chambliss, Daniel F., and Russell K. Schutt. 2018. *Making Sense of the Social World: Methods of Investigation*, 6th ed. New York: Sage Publications.

- Evergreen, Stephanie D.H. 2019. *Effective Data Visualization: The Right Chart for the Right Data*. Thousand Oaks, 2<sup>nd</sup> ed. New York: Sage Publications.
- Miller, Jane E. 2021. *Making Sense of Numbers: Quantitative Reasoning for Social Research*. New York: Sage Publications.
- \_\_\_\_\_. 2015. *The Chicago Guide to Writing about Numbers*, 2<sup>nd</sup> ed. Chicago: University of Chicago Press.
- \_\_\_\_\_. 2013. "Getting to Know Your Variables: An Exercise to Prepare Students to Undertake Data Analysis." *Proceedings of the American Statistical Association, Statistical Literacy Section*. Alexandria, VA: American Statistical Association, pp. 2016-27.  
<https://doi.org/10.13140/2.1.1041.9525>
- Salkind, Neil J. 2016. *Statistics for People who (Think They) Hate Statistics*, 6th ed. New York: Sage Publications.
- Utts, Jessica, and Robert Heckard. 2014. *Mind on Statistics*, 5th ed. Independence, KY: Cengage, Brooks Cole.