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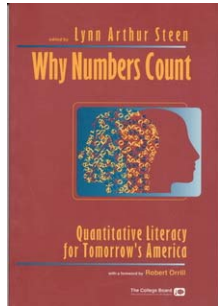
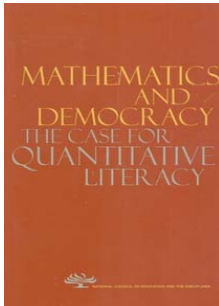
**Levels of Numeracy:
How Much Critical Thinking?**

Milo Schield
VP NNN
Professor at Augsburg University
Elected member: International Statistical Institute
US Rep: International Statistical Literacy Project
Teaches Statistical Literacy & Critical Thinking

NNN Annual Meeting: Barnard College
November 19, 2017
www.StatLit.org/pdf/2017-Schild-NNN-Slides.pdf



V0B 2017 NNN1 2

Numeracy Reference Books
Steen, Ed. 1997 Steen+Madison, Ed. 2001

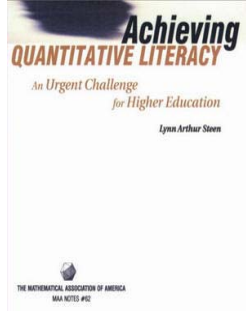
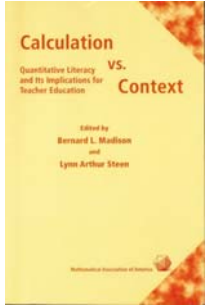
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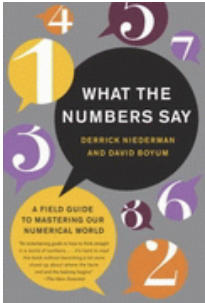
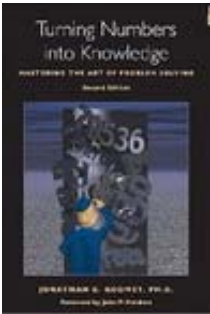
V0B 2017 NNN1 4

Numeracy Reference Books
Steen 2004 Steen+Madison 2008

V0B 2017 NNN1 5

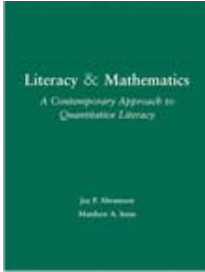
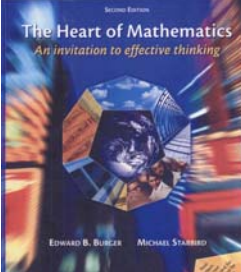
Professional Books
Niederman .. 2003 Kooney 2000

V0B 2017 NNN1 6

Reference Books

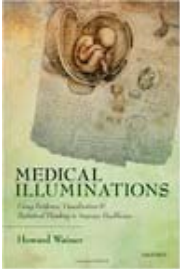
Abramson+Isom, 2005 Berger+Starbird 2004

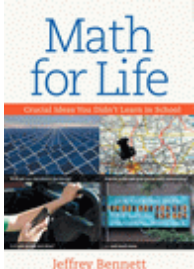
V0B 2017 NNN1 7

Professional Books

Wainer 2013



Bennet 2011



V0B 2017 NNN1 8

Five Levels of Numeracy

Level	Description
5	From Association to Causation
4	Social Construction: Definitions
3	Confounding and Study Design
2	Ratios & Numbers in the News
1	Traditional Q/R


V0B 2017 NNN1 9

Level 1 Books: Math: Traditional QR/QL

Gillman, Ed. 2006

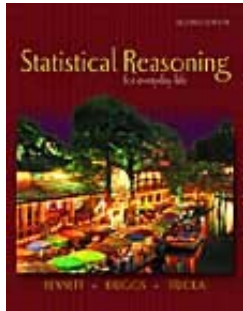
Chapters by Briggs, Ganter, Bressoud, Sons, Taylor, Sevilla & Somers, etc.

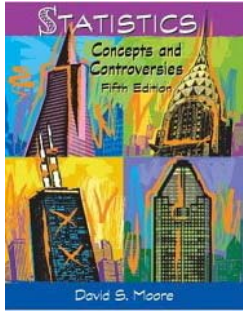
Consensus: Q/L should include *elementary logic, math of finance descriptive stats, finite probability linear and exponential models, estimations, approximation, and general problem solving.*



V0B 2017 NNN1 10

Level 1 Textbooks: Statistical Reasoning







V0B 2017 NNN1 11

Level 2 Textbooks: Ratios & Numbers in News

Madison...2nd ed 2003

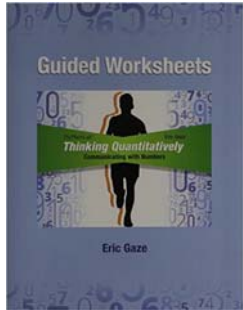



Sevilla+Somers 2007



V0B 2017 NNN1 12

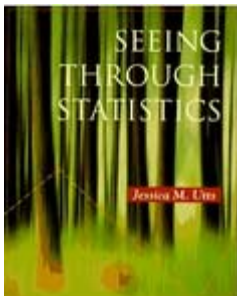
Level 2 Textbooks: Ratios & Numbers in News






VOB 2017 NNN1 13

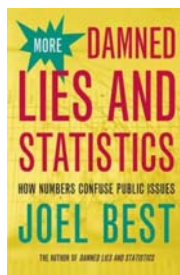
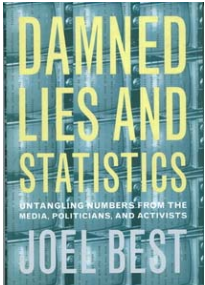
Level 3 Textbooks: Statistics Confounding, Study Design



VOB 2017 NNN1 14

Level 4 Reference Books: Social Construction


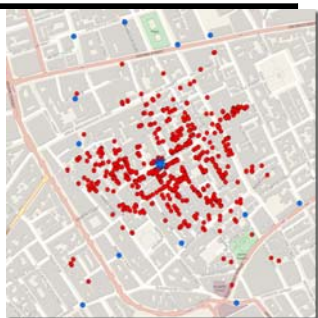
Best 2001  Best 2004

VOB 2017 NNN1 15

Level 5 Epidemiology: From Association to Causation



John Snow:
Cholera map 1854

VOB 2017 NNN1 16

Level 5 Epidemiology: From Association to Causation



Another triumph: Smoking causes lung cancer.
Evidence: Large effect size & biological gradient.

Richard Doll  Bradford-Hill 

VOB 2017 NNN1 17

Level 5 History: From Association to Causation

Fisher versus Cornfield. Fisher dissented.

VOB 2017 NNN1 18

Level 5 History: From Association to Causation

“Cornfield's minimum effect size is as important to observational studies as is the use of randomized assignment to experimental studies.

While there might be many confounding factors, only those exceeding certain necessary conditions [the observed effect size] could be relevant.”

“This is one of the most important contributions of statistics to human knowledge.”


Schild (1999). See www.statlit.org/Cornfield.htm

V0B 2017 NNN1 19

Critical Thinking: Support

Cause of quantitative literacy faces two challenges:

1. recognizing that Q/L must encompass more than matters of calculation, and
2. finding ways to integrate Q/L -- and critical thinking more generally -- into the curriculum.”



Joel Best (2008) “Beyond Calculation: Quantitative Literacy and Critical Thinking about Public Issues” in *Calculation vs. Context*.

V0B 2017 NNN1 20

Critical Thinking Caution #1


Investigators tend to neglect the difficulties in establishing causal relations, and the mathematical complexities obscure rather than clarify the assumptions on which the analysis is based.

David Freedman (1999). From association to causation: some remarks on the history of statistics in *Statistical Science* Vol 14, #3. 243-258.
<https://projecteuclid.org/euclid.ss/1009212409>
<https://www.stat.berkeley.edu/~census/521.pdf>

V0B 2017 NNN1 21

Critical Thinking: Caution #2

Earlier innovative, QL-type courses "had one thing in common that contributed to their remaining a small elective rather than a major requirement.
They were designed specifically to focus on ideas -- generally QL-like ideas -- rather than techniques.
 This made them more difficult for teachers to teach and for students to master. they thrived only in special niches out of the mainstream of college mathematics."
 Lynn Steen, *Achieving Q/L* (2004). P. 39



V0B 2017 NNN1 22

Discussion

Should NNN promote critical thinking about:

- ratios: rates and percentages (Level 2)?
- confounding and study design (Level 3)?
- the social constructions of statistics (Level 4)?
- using associations as evidence for causation in observational studies (Level 5)?

V0B 2017 NNN1 23

Recommendation

NNN should promote critical thinking about:

- ratios: rates and percentages (Level 2)
- confounding and study design (Level 3)
- the social constructions of statistics (Level 4)

but **not** about using associations as evidence for causation in observational studies (Level 5)
 This sets NNN apart from the MAA and the ASA.
 This puts NNN one the edge of critical thinking!

V0B 2017 NNN1 24

References

Scheaffer, Richard (2003). Statistics and Quantitative Literacy in *Q/L: Why Numeracy Matters for Schools & Colleges* MAA p 145-152
www.maa.org/sites/default/files/pdf/QL/WhyNumeracyMatters.pdf

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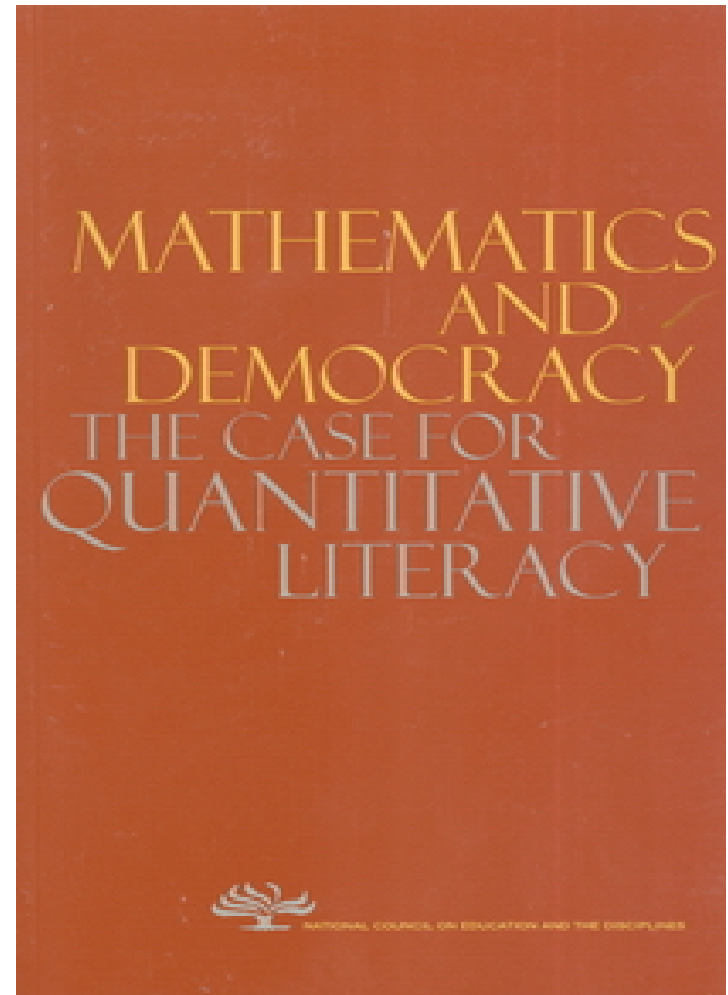
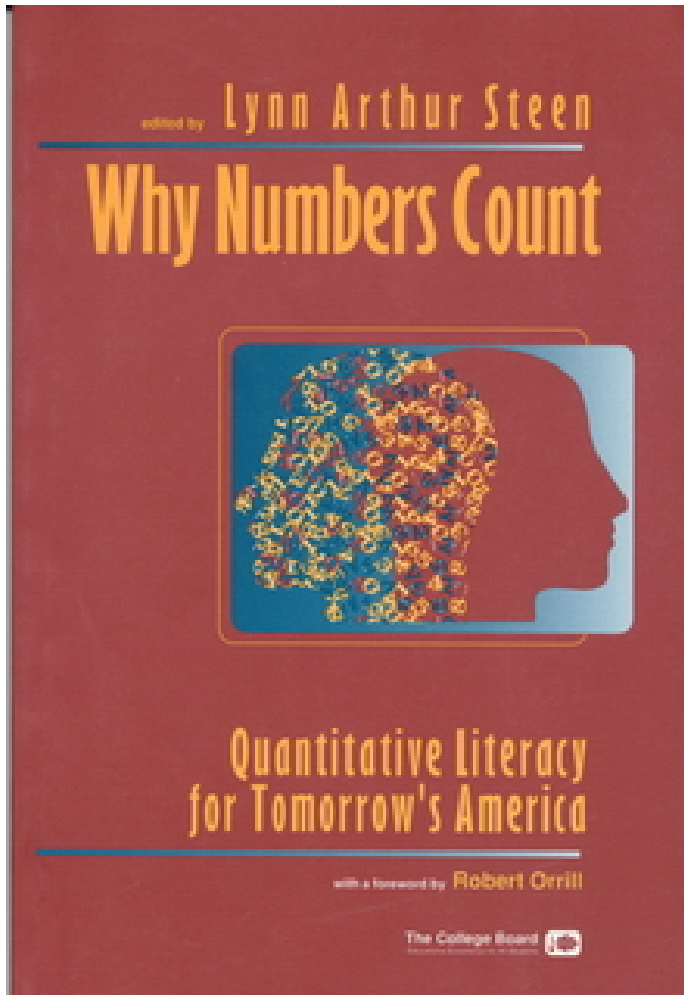
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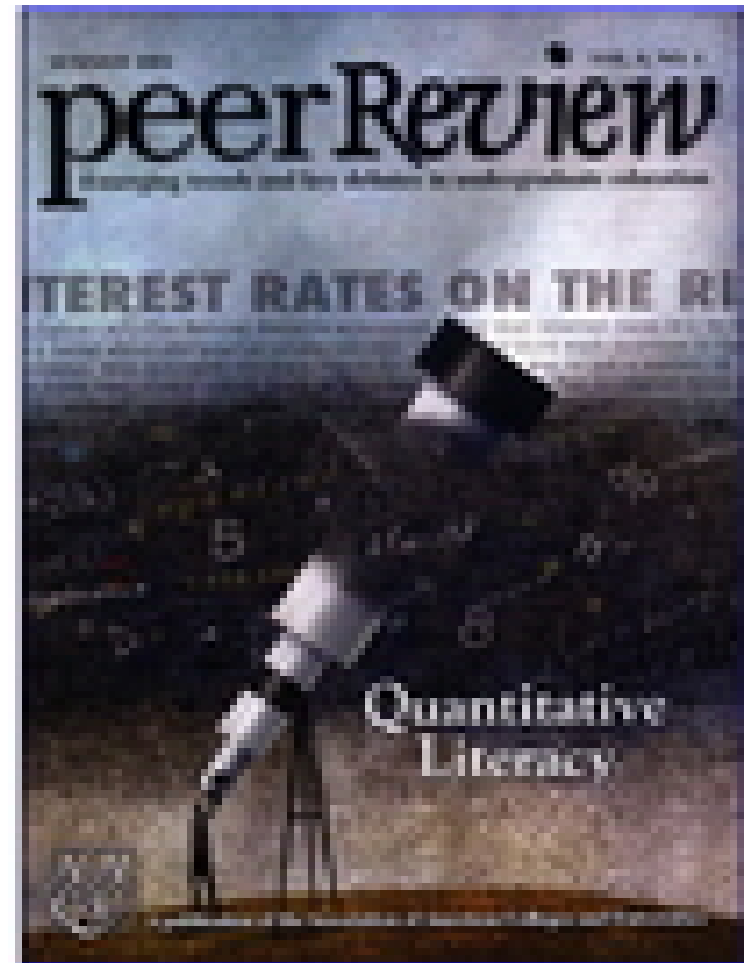
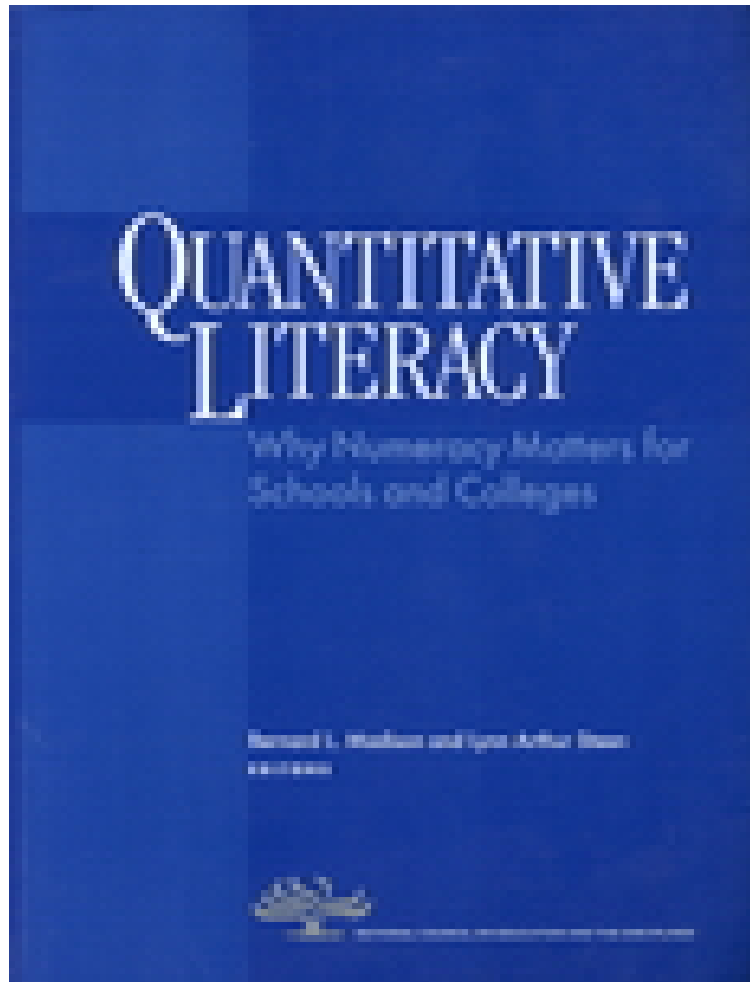
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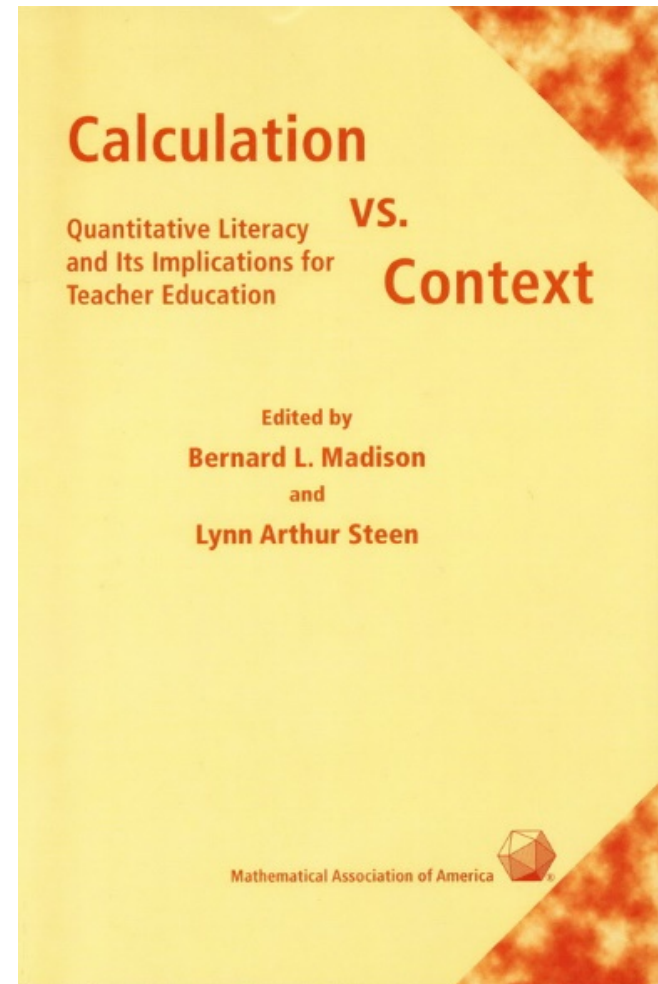
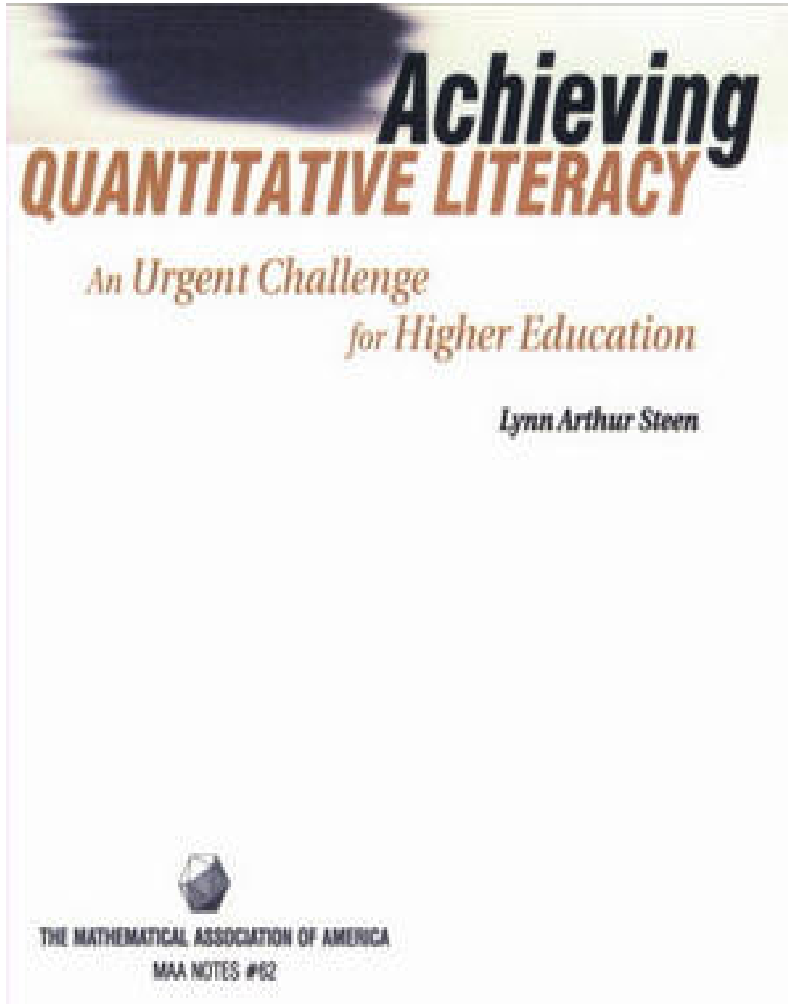
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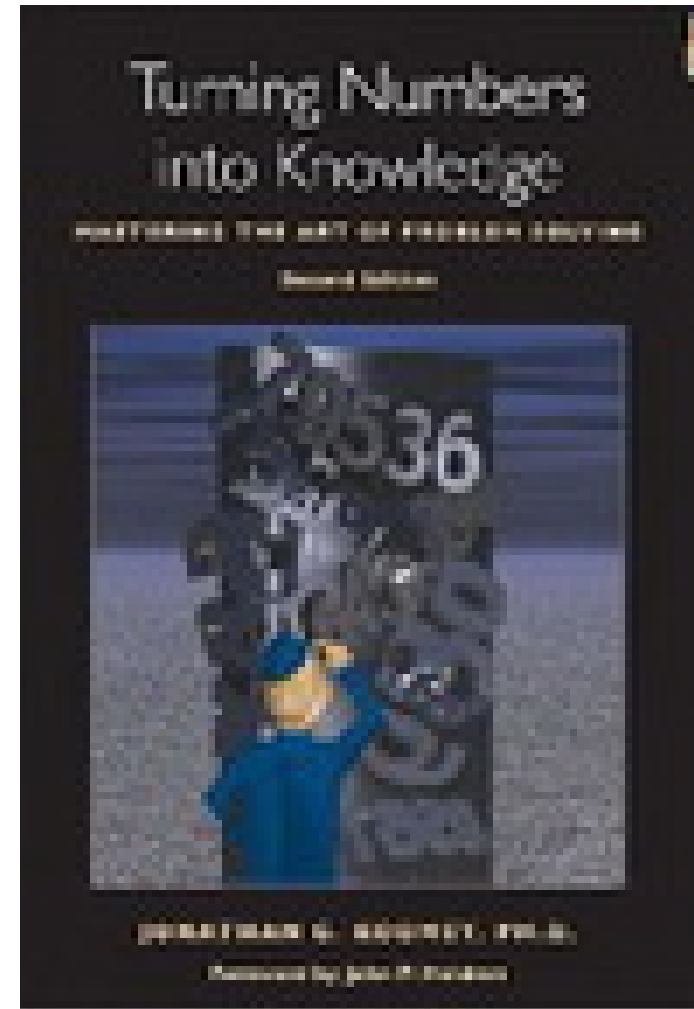
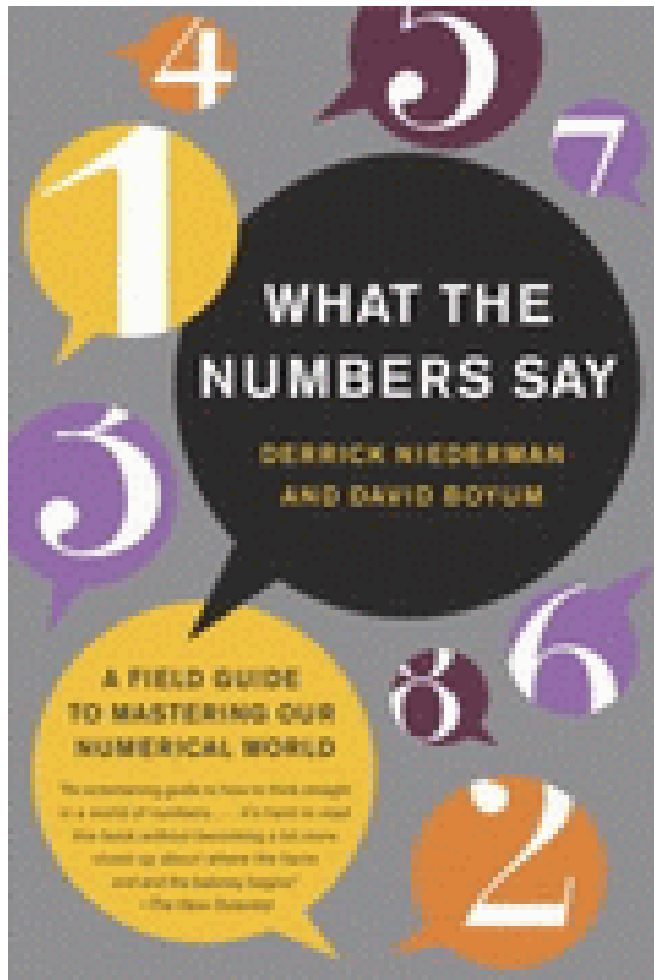
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Professional Books

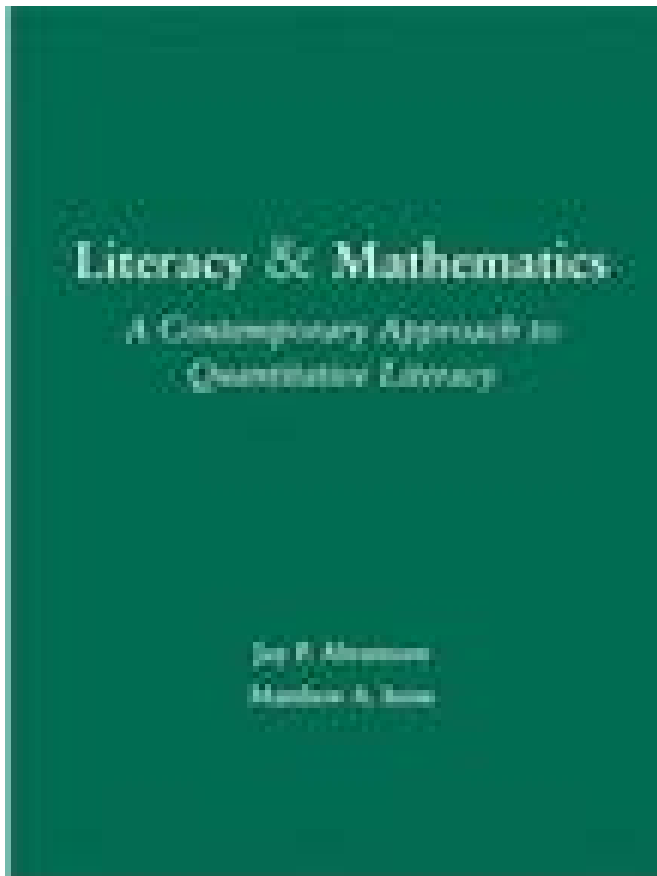
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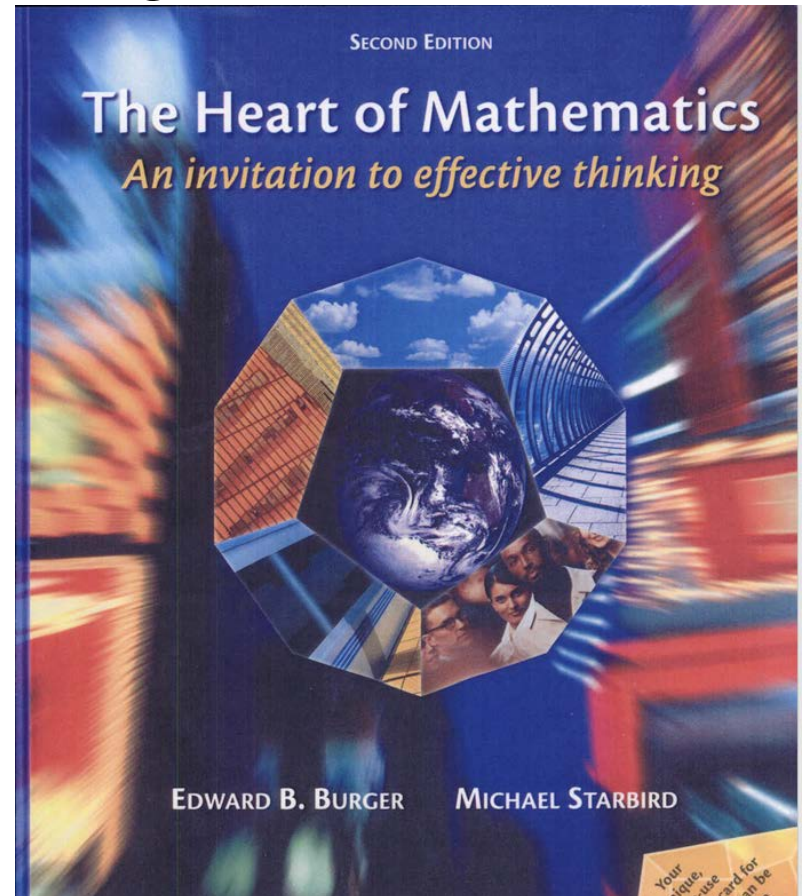


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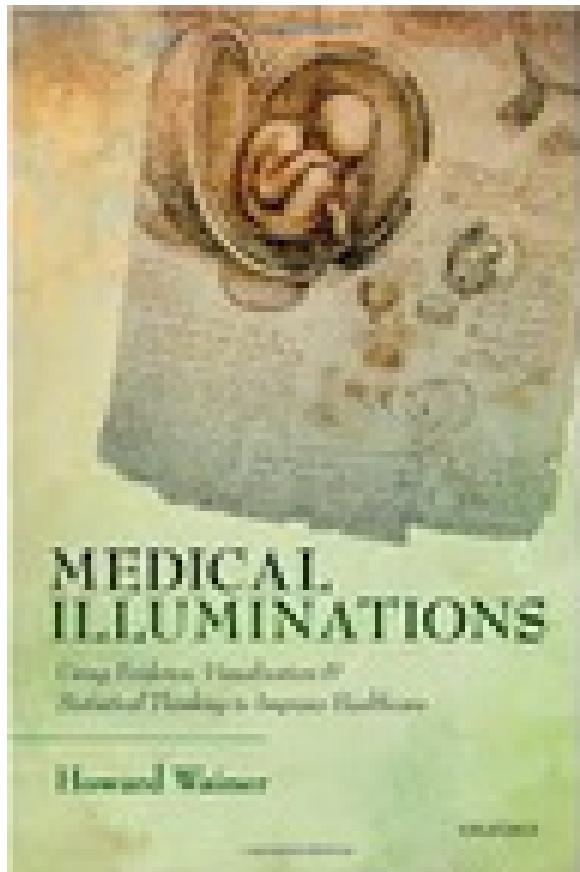


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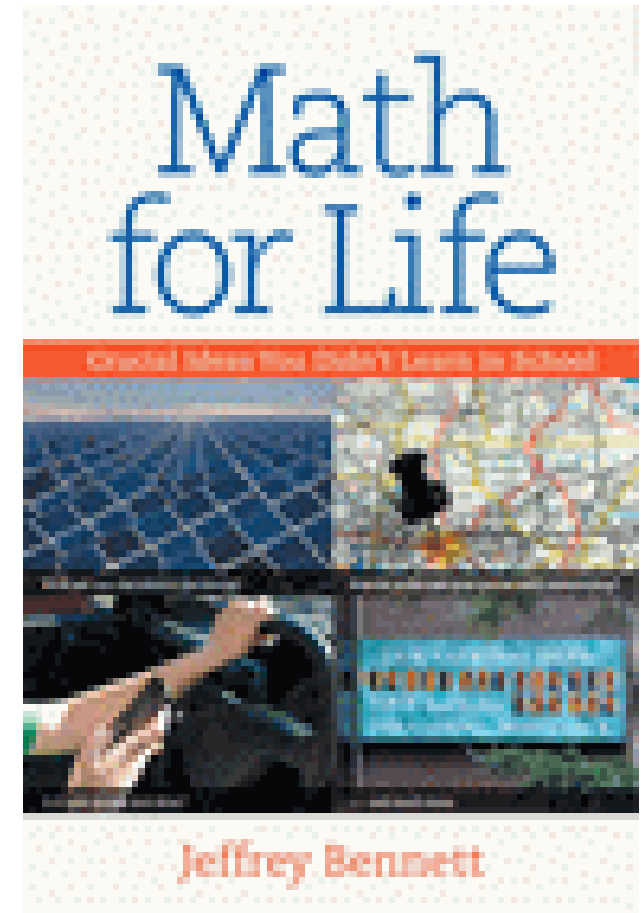


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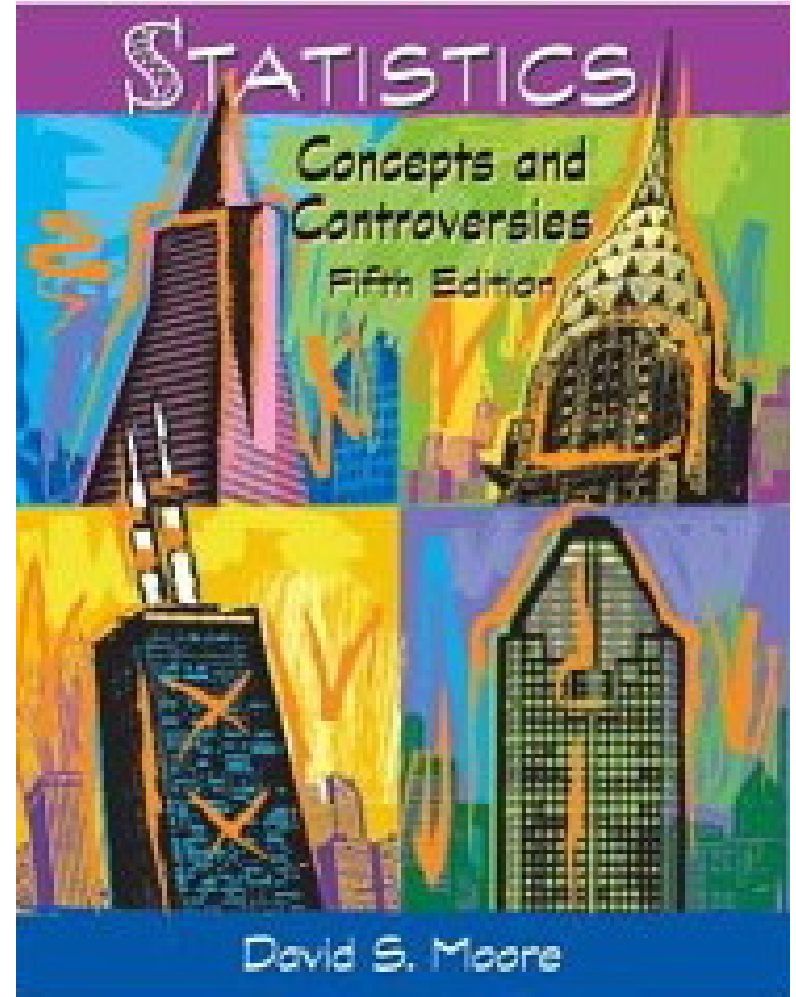
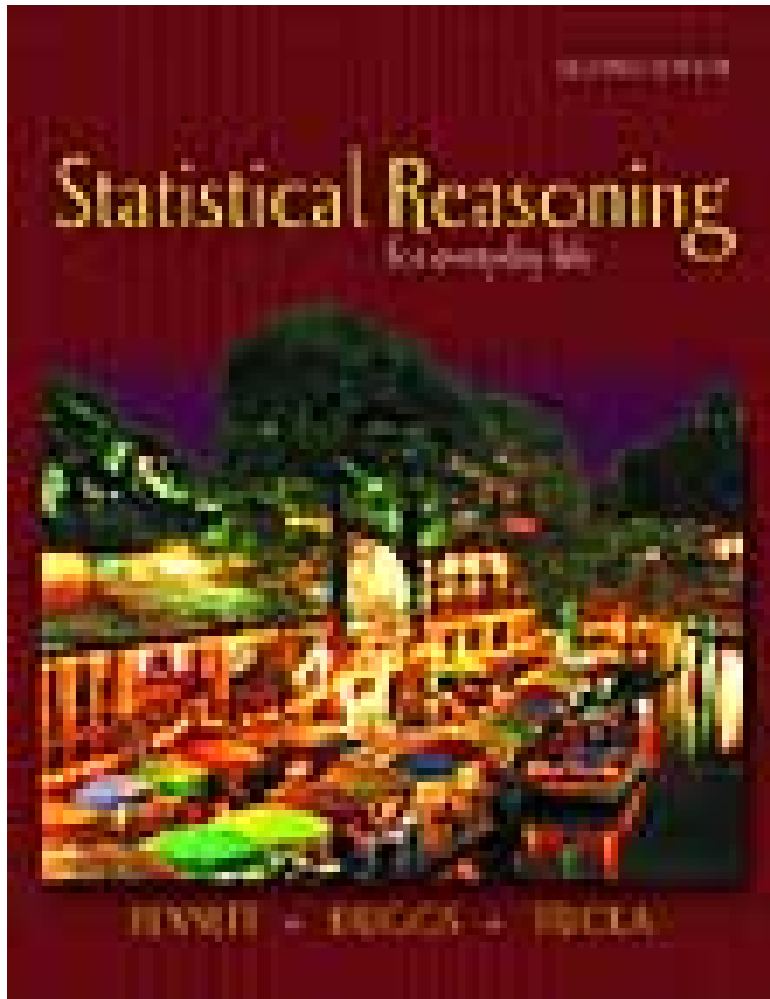
Current Practices in Quantitative Literacy

Rick Gillman, Editor
MAA Notes #70



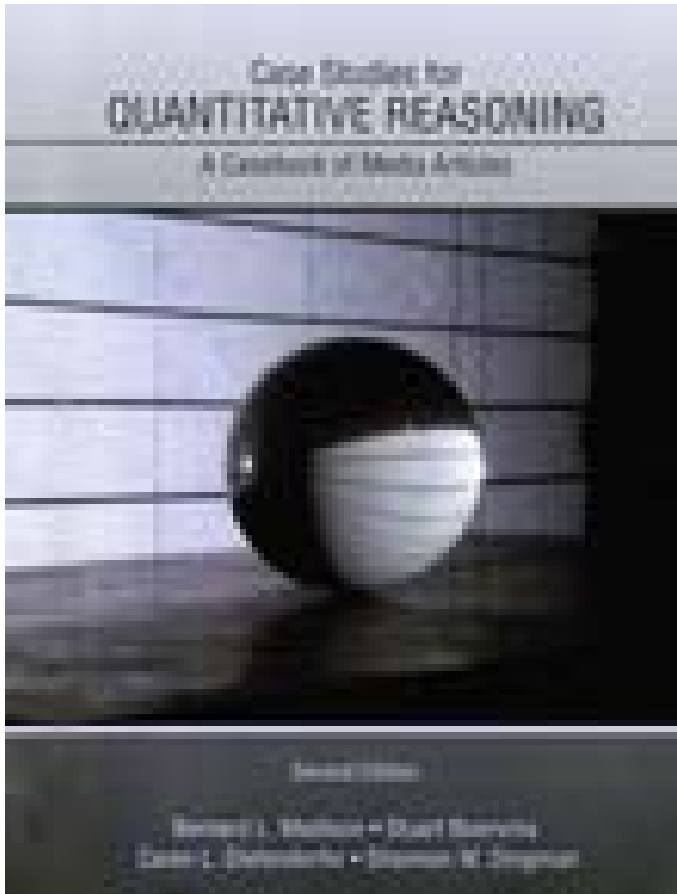
Mathematical Association of America

Level 1 Textbooks: Statistical Reasoning

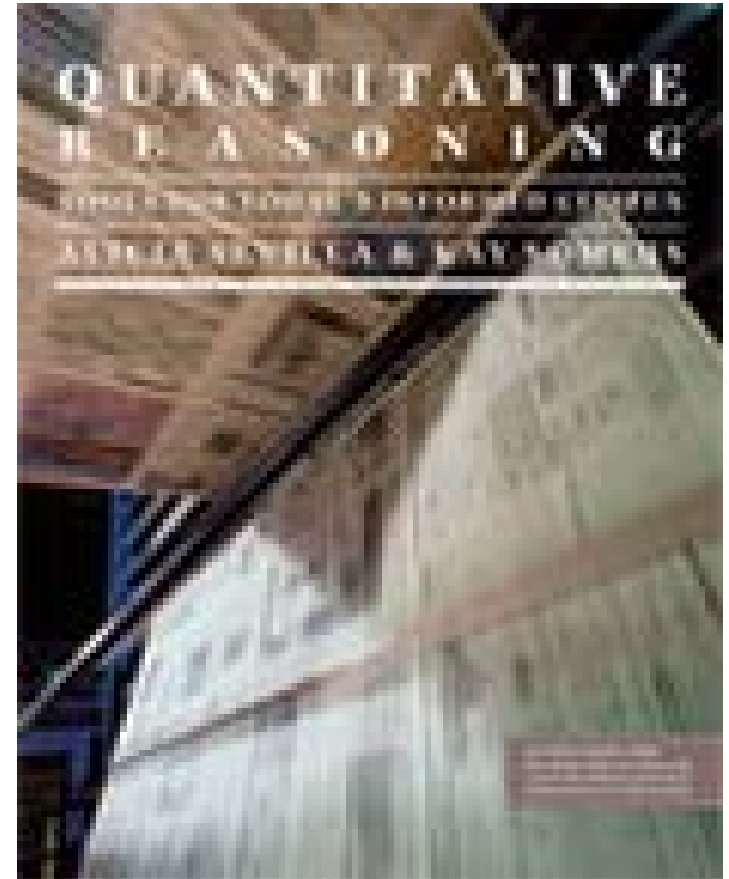


Level 2 Textbooks: Ratios & Numbers in News

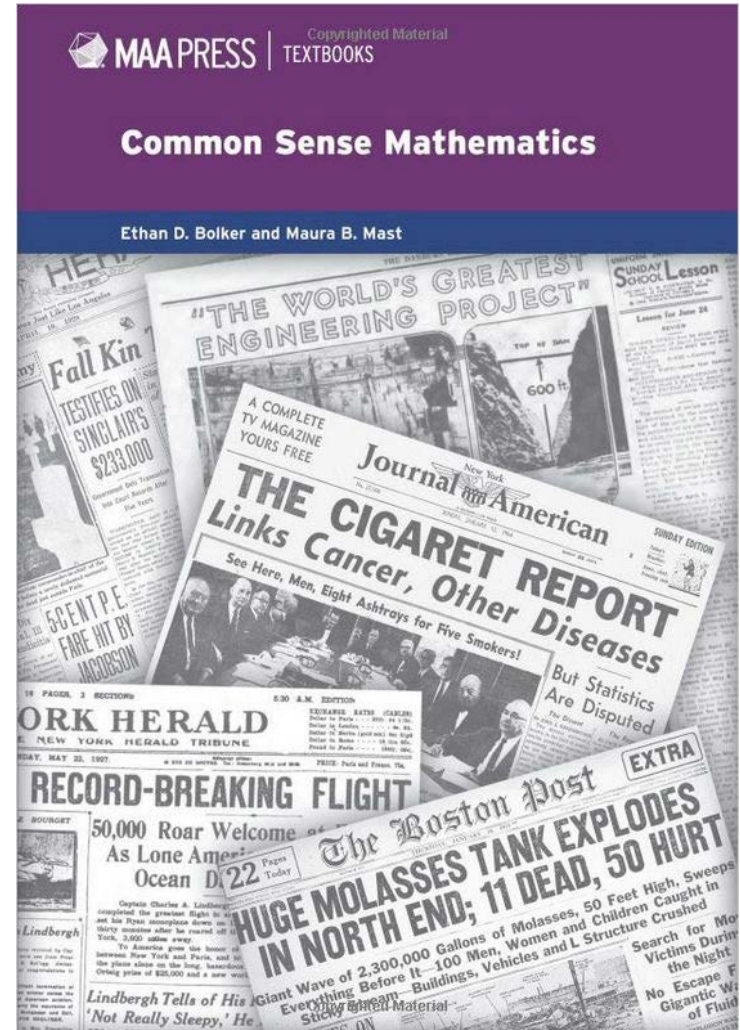
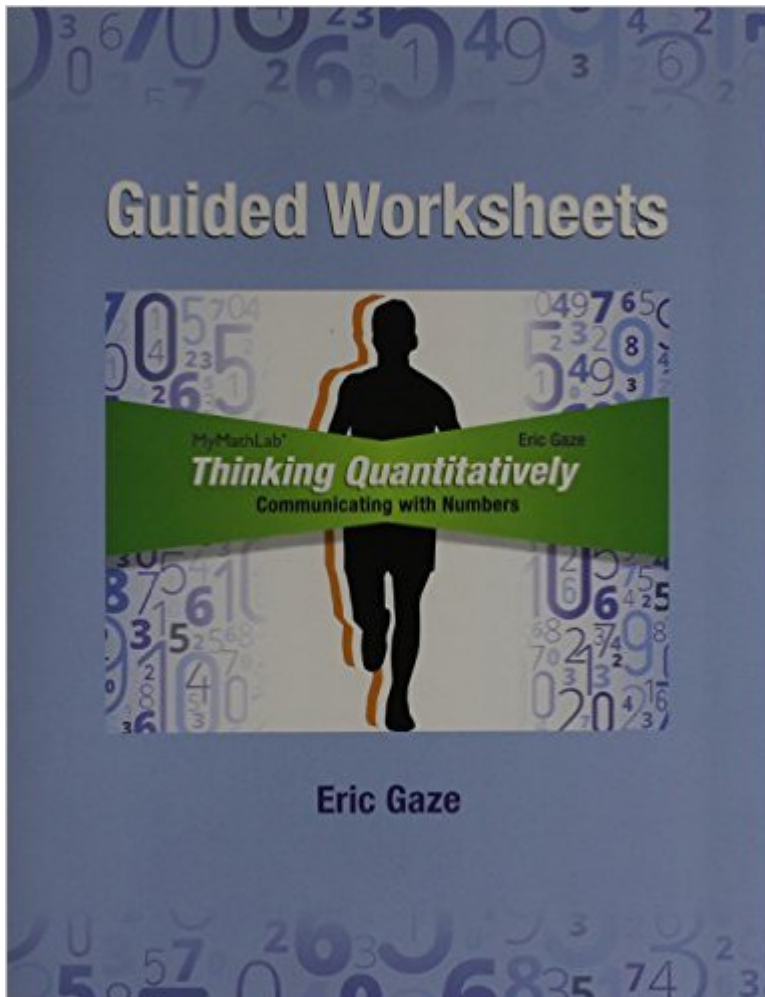
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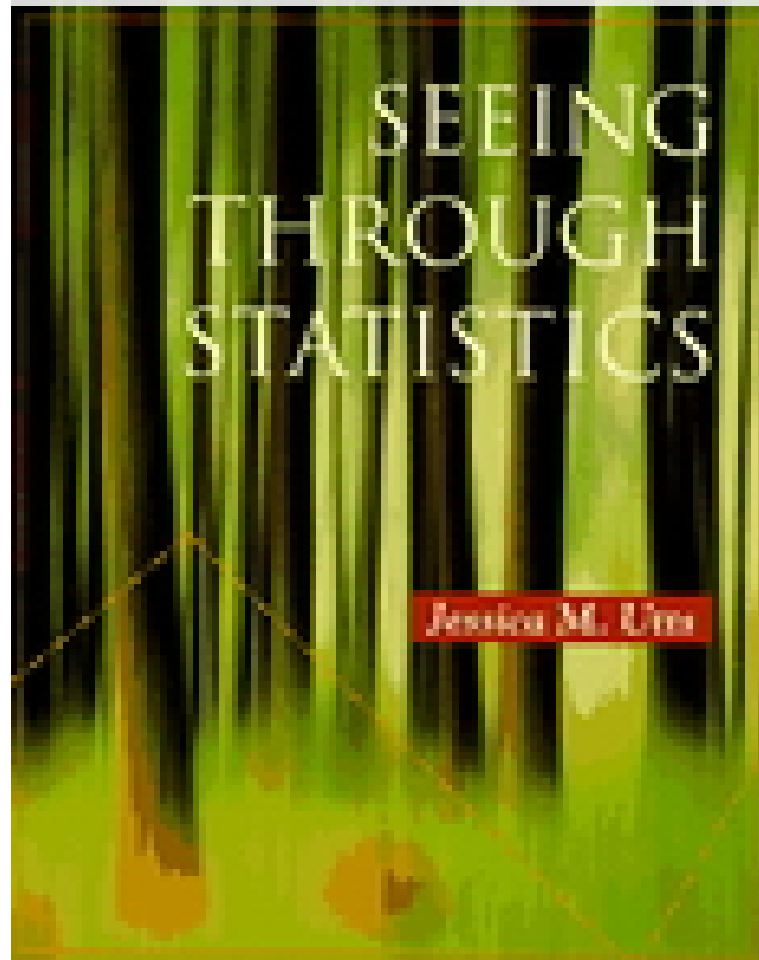
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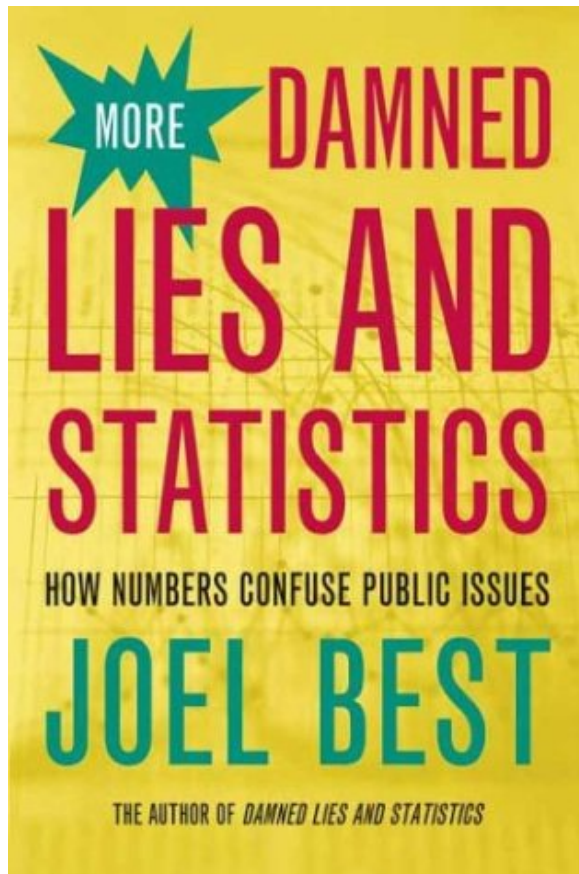


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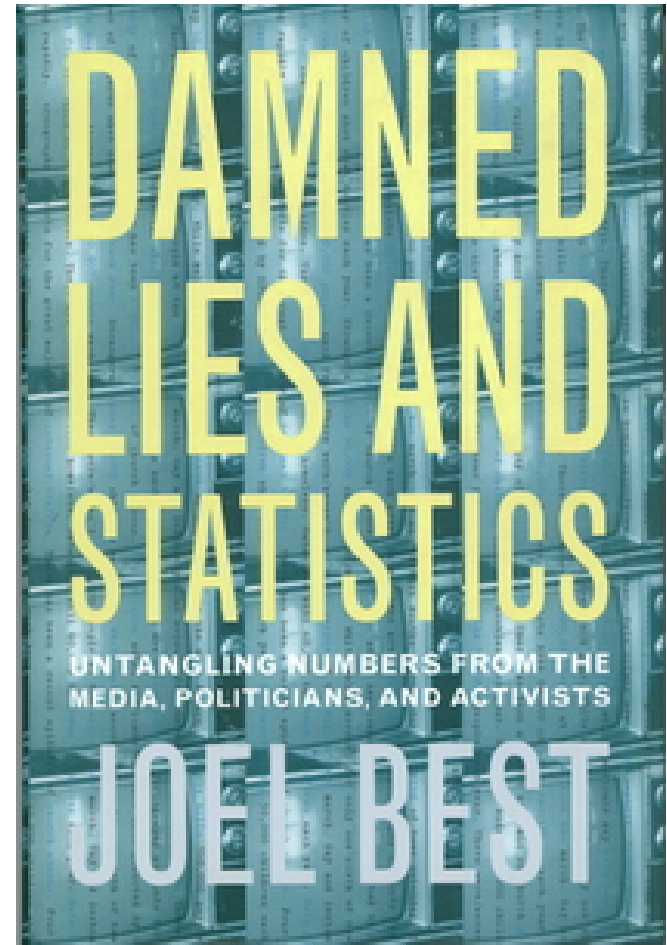


Level 4 Reference Books: Social Construction

Best 2001

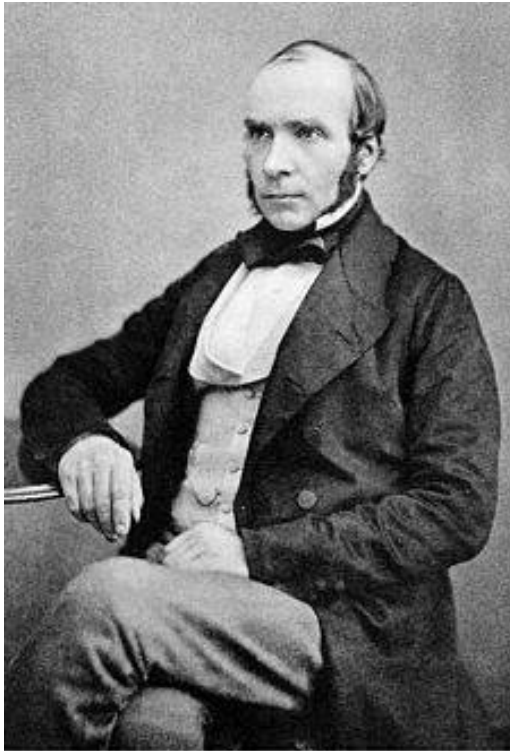


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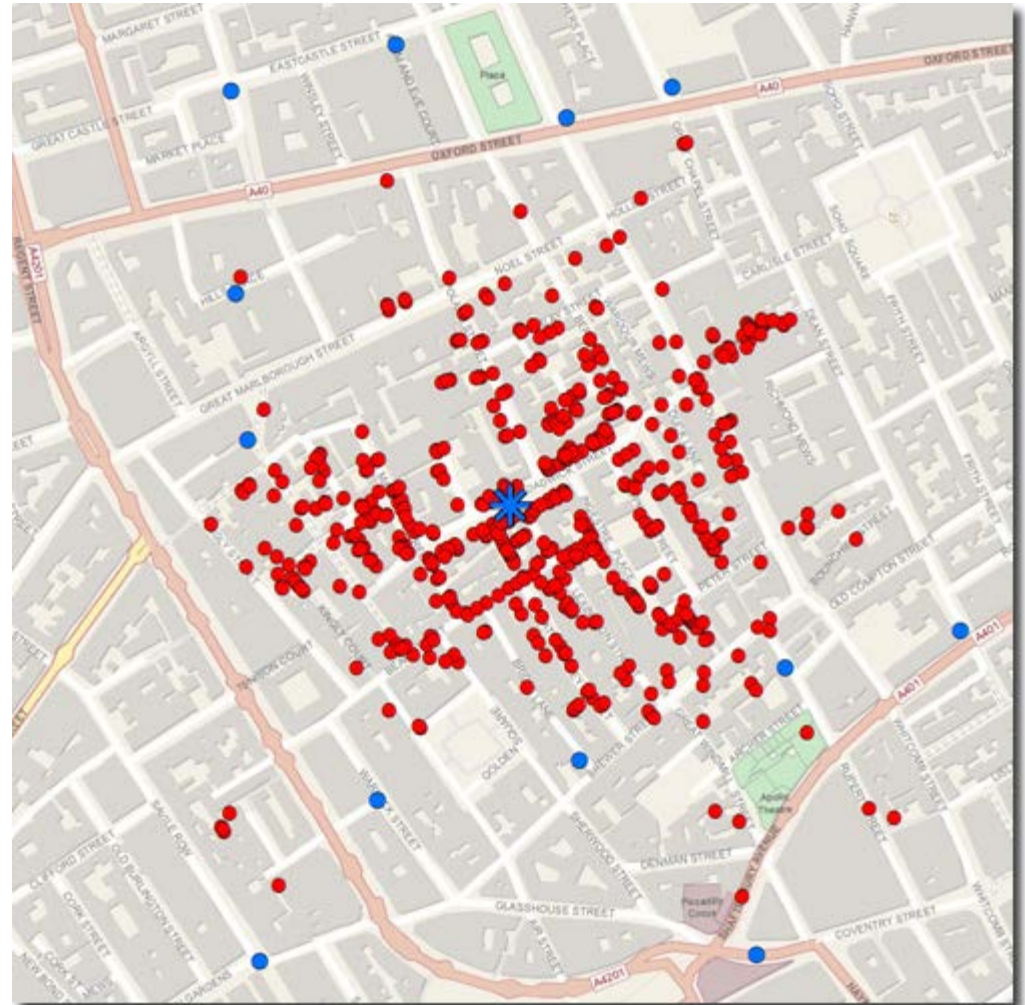


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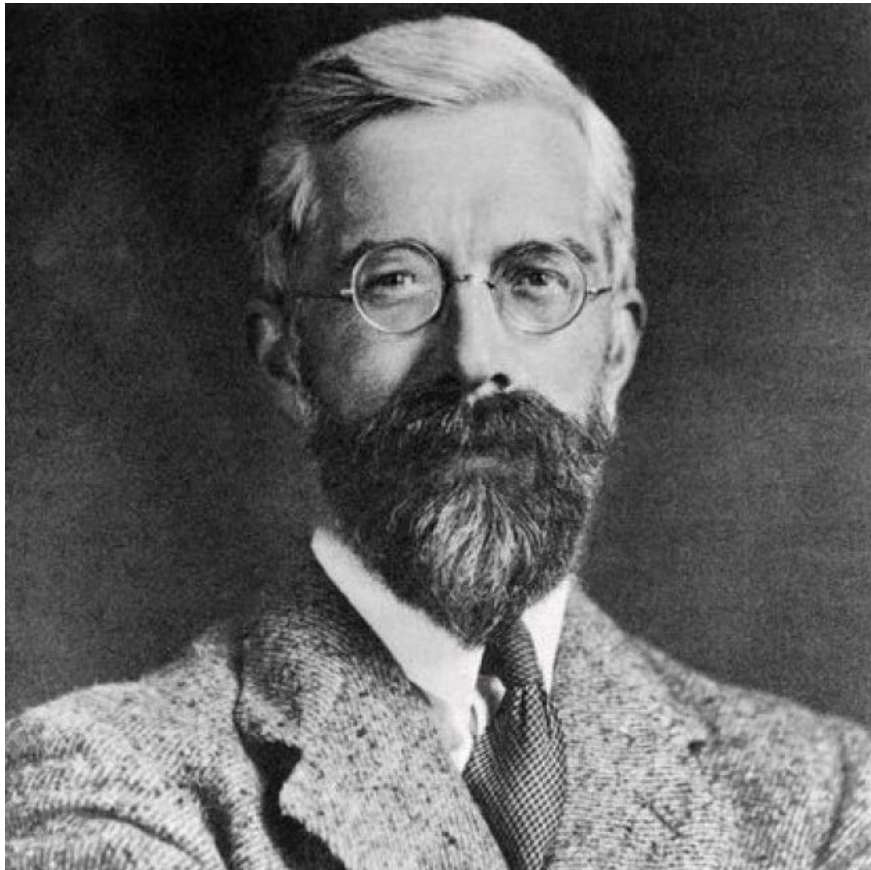


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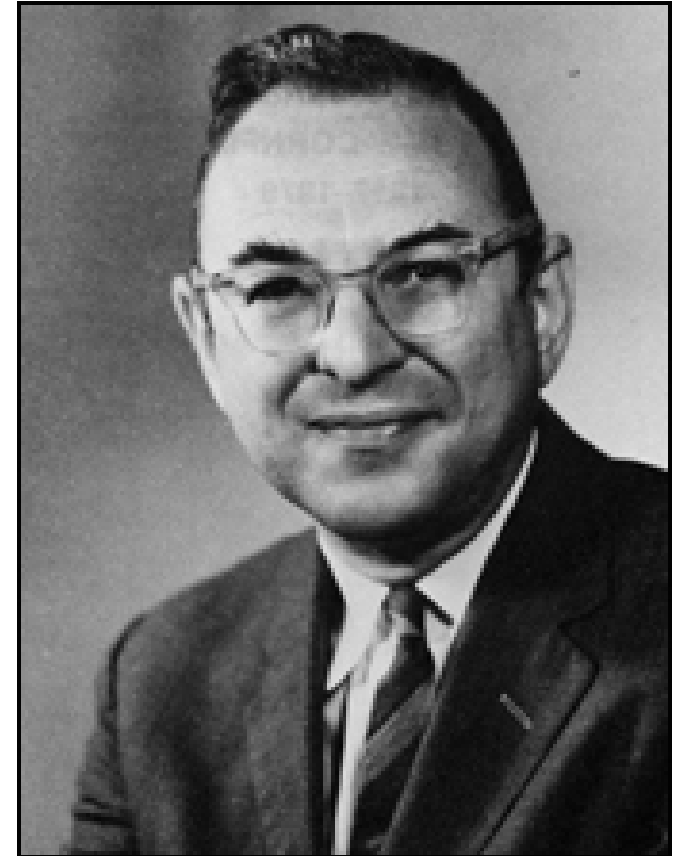


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