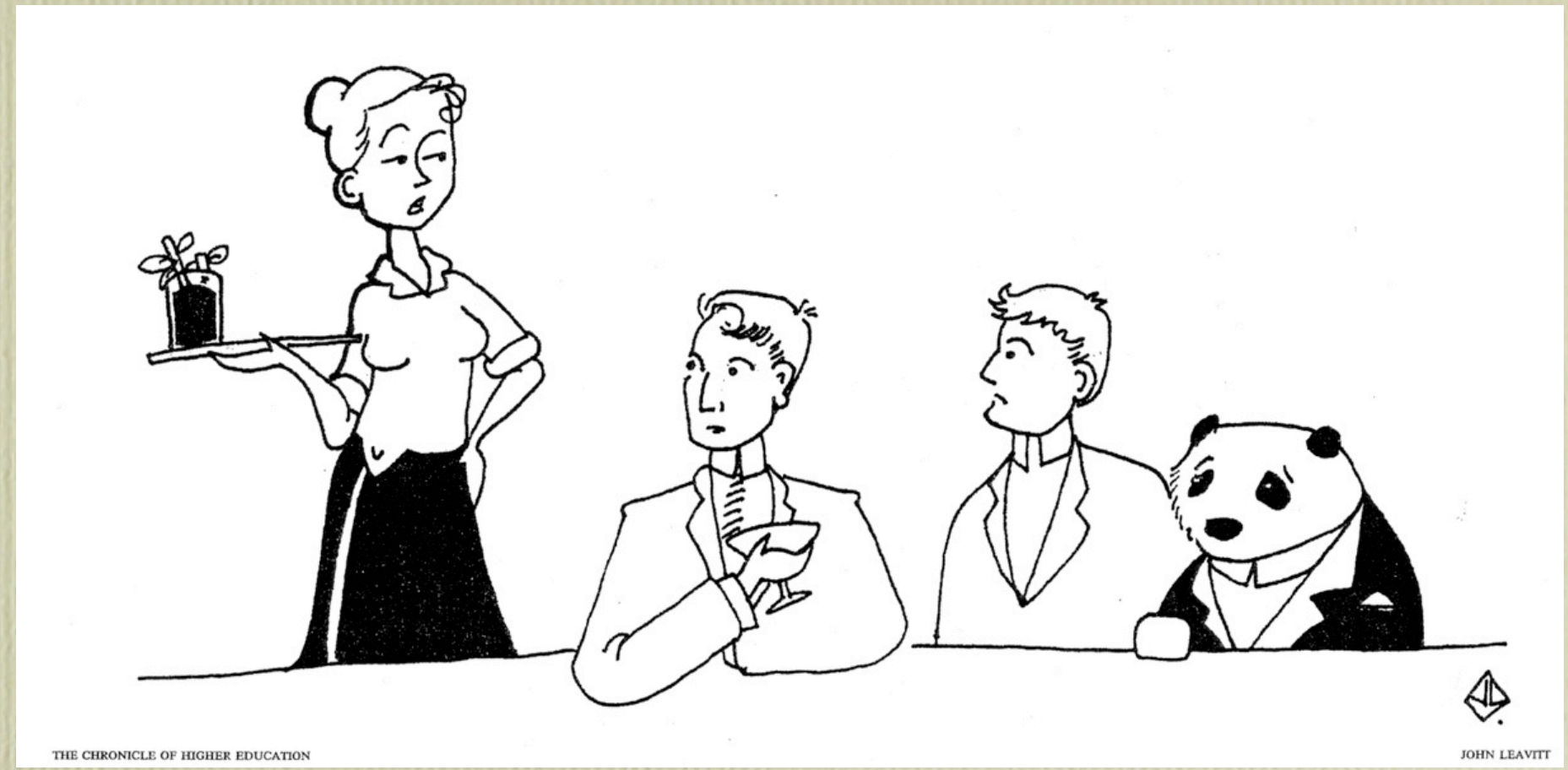
Illuminating Arguments with the Power of Numbers

Neil Lutsky
Carleton College

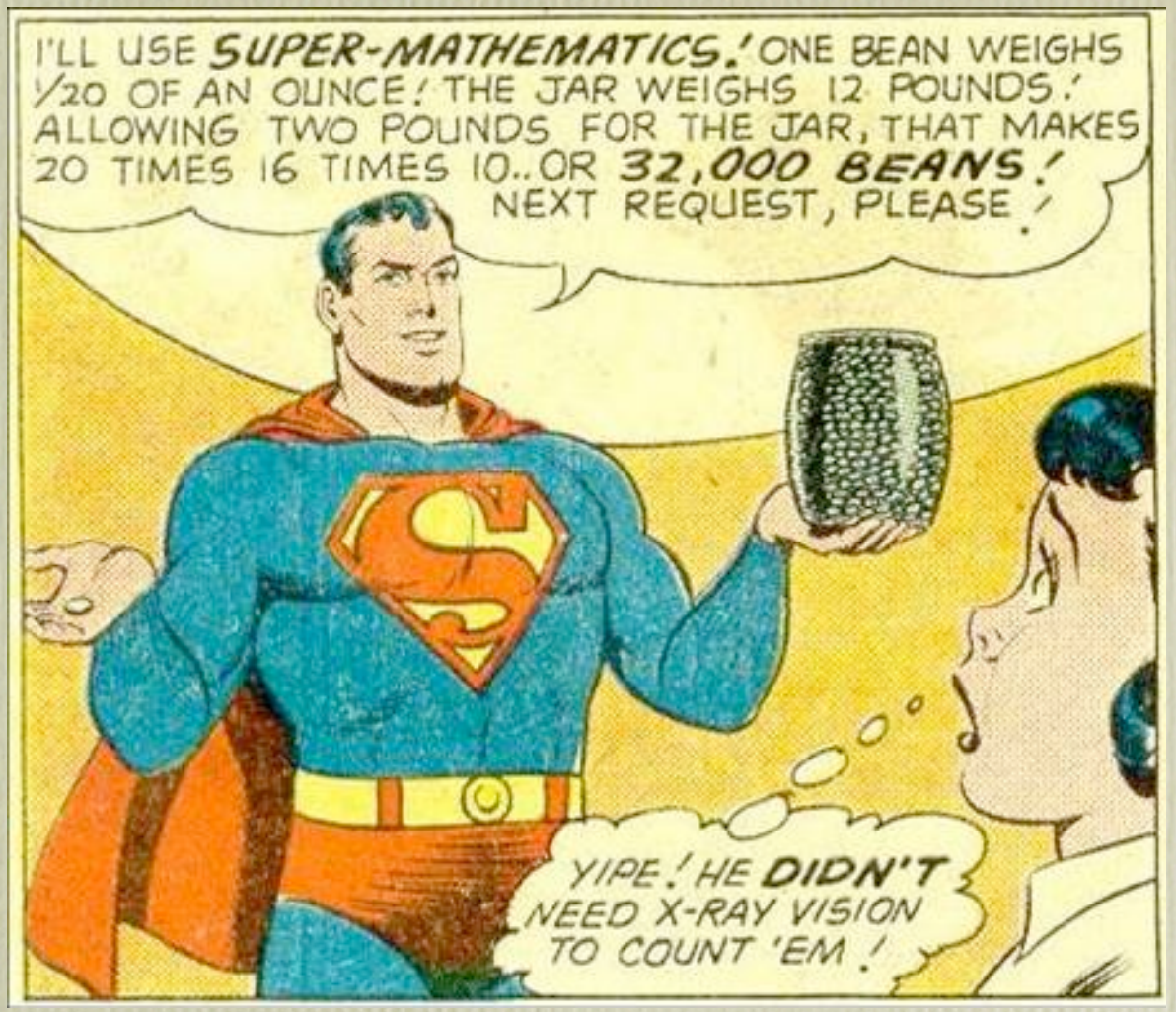


"Who ordered the bamboo-bug smoothie?"

Deborah Hughes Hallett on QL

"The ability to identify, understand, and use elementary mathematics in everyday contexts."

- *Arithmetic.*
- *Estimation.*
- *Elementary Probability and Statistics.*
- *Geometry and Measurement.*
- *Elementary Growth Patterns.*


I'LL USE SUPER-MATHEMATICS! ONE BEAN WEIGHS 1/20 OF AN OUNCE! THE JAR WEIGHS 12 POUNDS! ALLOWING TWO POUNDS FOR THE JAR, THAT MAKES 20 TIMES 16 TIMES 10.. OR 32,000 BEANS! NEXT REQUEST, PLEASE!
YIPE! HE DIDN'T NEED X-RAY VISION TO COUNT 'EM!

20 x 16 x 10 = ?

"JUST HOW MANY PAIRS OF EARRINGS WILL YOU ACTUALLY NEED ON THIS VOYAGE?" SNAPPED THE FIRST MATE

Deborah Hughes Hallett on QL

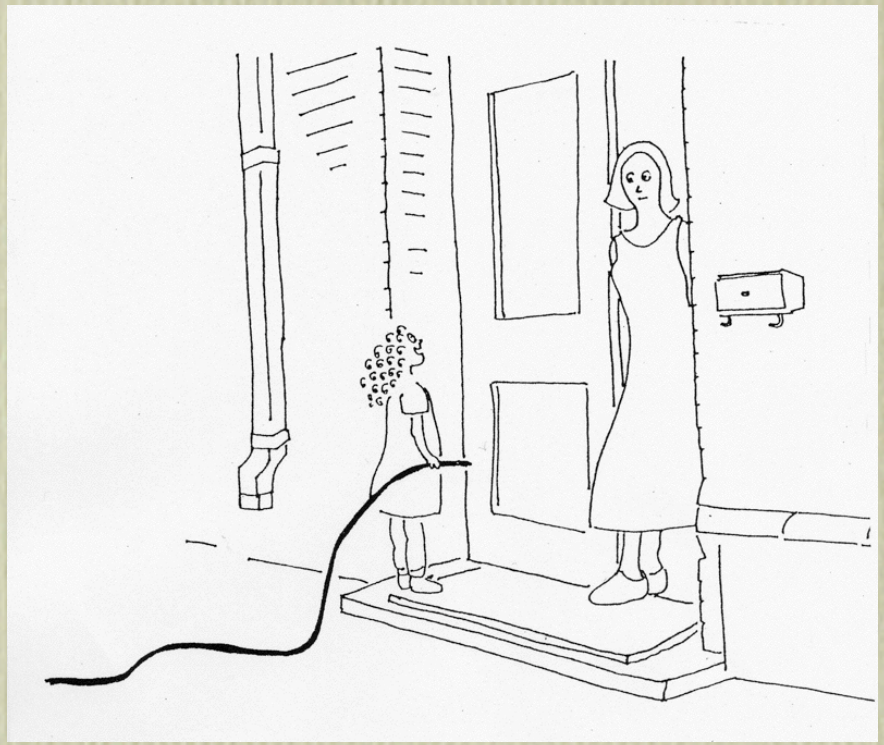
"The ability to identify, understand, and use elementary mathematics in everyday contexts."

- *Arithmetic.*
- *Estimation.*
- *Elementary Probability and Statistics.*
- *Geometry and Measurement.*
- *Elementary Growth Patterns.*

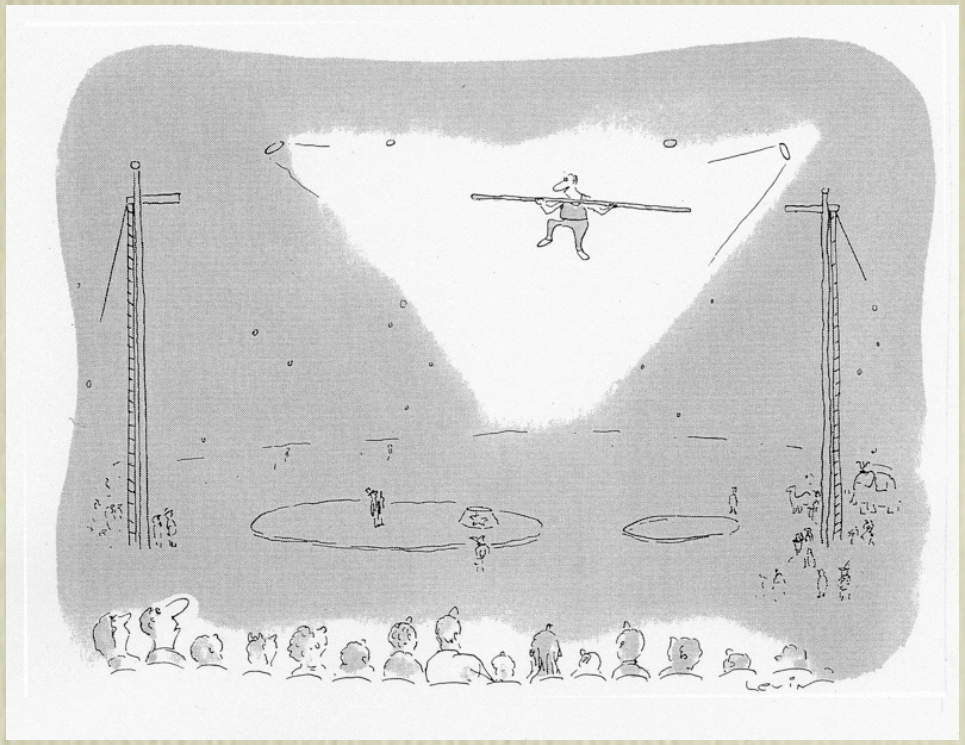
My Argument Today:

- Times have changed.
- QR is less about *the manipulation of numbers* than it is about *the evaluation and construction of arguments*.
- Thinking about QR in terms of arguments has implications for what we teach when we address QR, who teaches QR, and the forms QR programs take.

I. Times have changed:

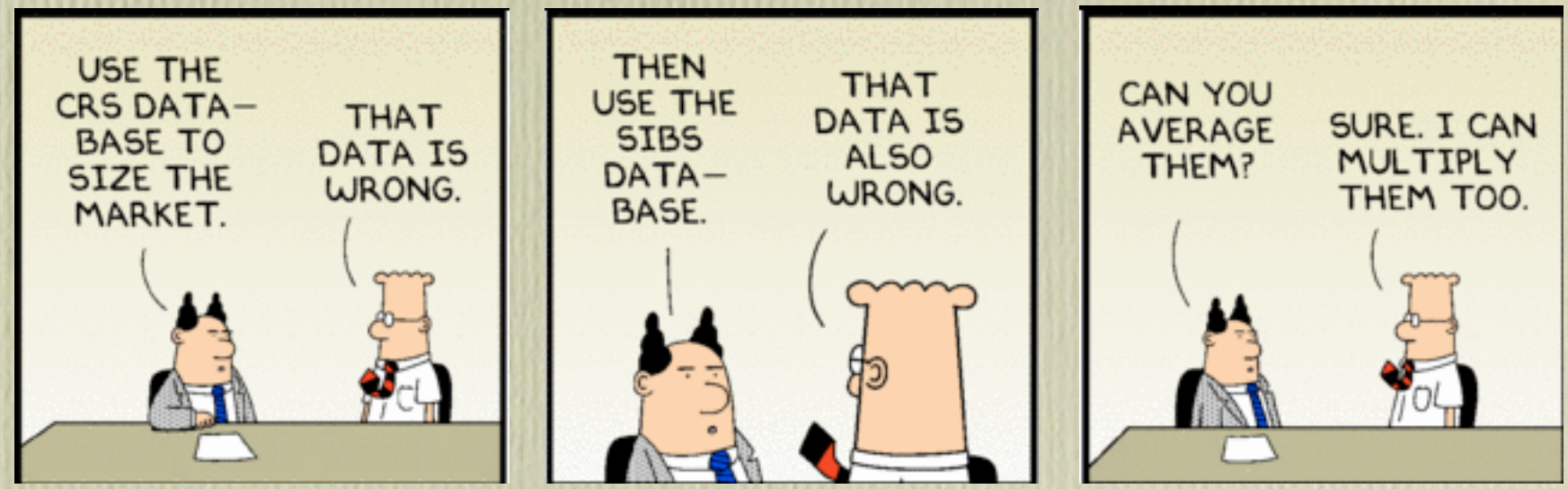


"Look, Mom! A broadband digital subscriber line followed me home. Can we keep it?"



"It appears to be some kind of wireless technology."

An important aside: *Can we trust the cartoon evidence?*

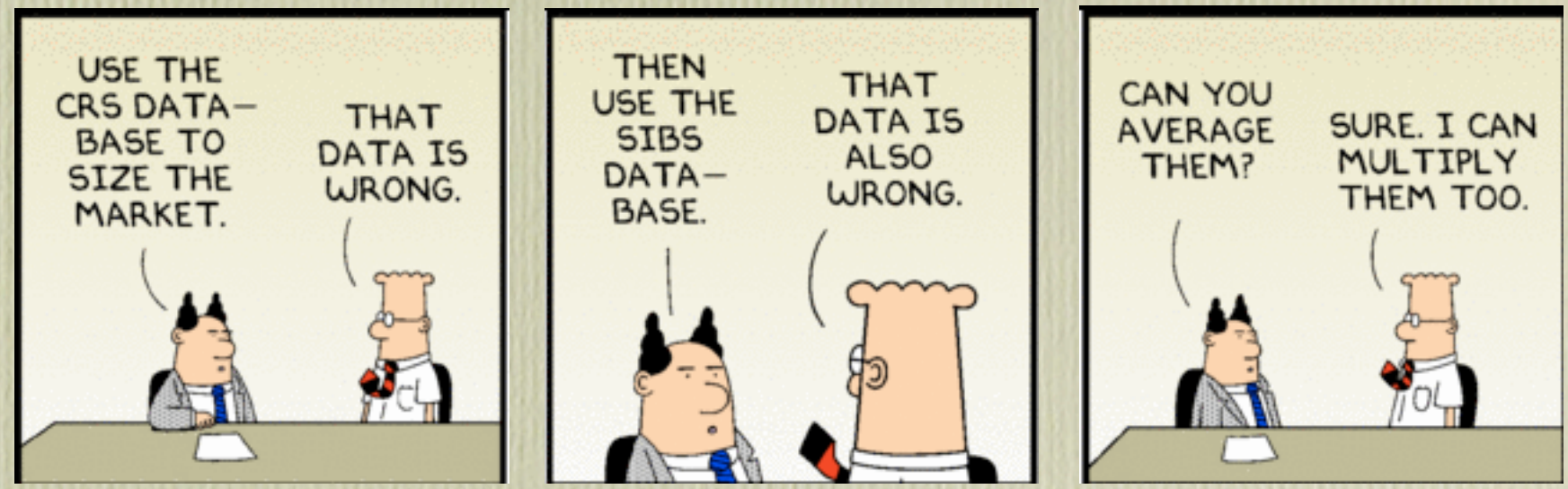


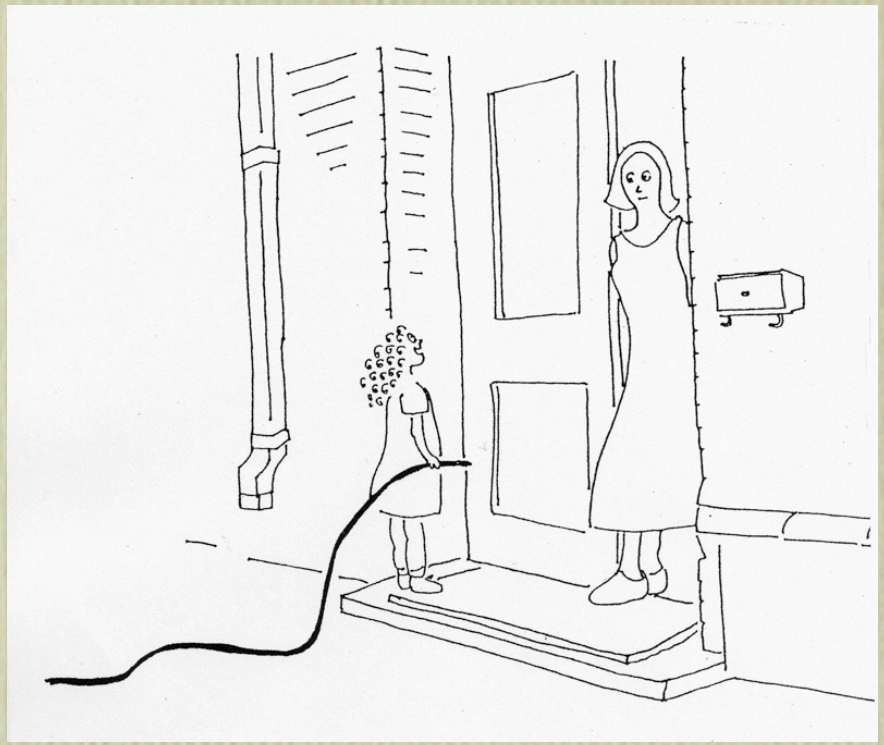
Chips in the Jar Demonstration:

Chips in the Jar Demonstration:

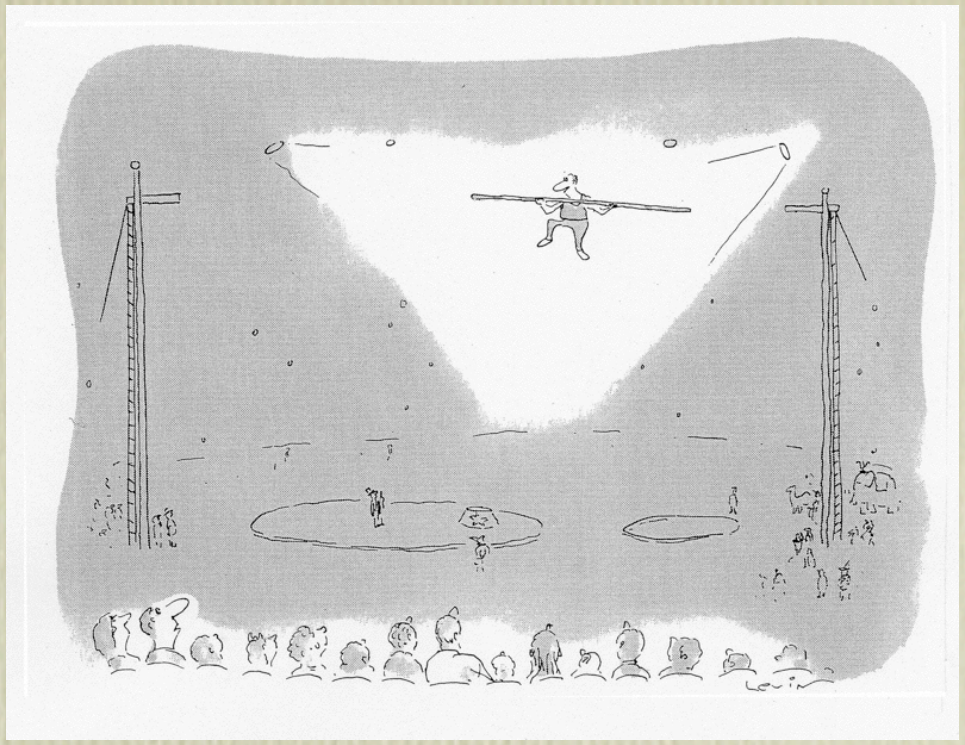
- Actual number of chips: **134**
- Mean of group guesses: **137**
- *No individual in my class came closer to the correct answer than the group mean did!*
- James Surowiecki (2004), *The Wisdom of Crowds.*

An important aside: *Can we trust the cartoon evidence?*





"Look, Mom! A broadband digital subscriber line followed me home. Can we keep it?"



"It appears to be some kind of wireless technology."

I. Times have changed.

John Monks (1990), *Learning*

Wikipedia Celebrates 750 Years Of American Independence

Founding Fathers, Patriots, Mr. T. Honored

July 26, 2006 | Issue 42•30

NEW YORK—Wikipedia, the online, reader-edited encyclopedia, honored the 750th anniversary of American independence on July 25 with a special featured section on its main page Tuesday.

E-MAIL
PRINT
BLOG THIS

ENLARGE IMAGE

Three girls march toward the White House on Elm St. in Washington, DC, as part of the Inderpendance Day Parade.

"It would have been a major oversight to ignore this portentous anniversary," said Wikipedia founder Jimmy Wales, whose site now boasts over 4,300,000 articles in multiple languages, over one-quarter of which are in English, including 11,000 concerning popular toys of the 1980s alone. "At 750 years, the U.S. is by far the world's oldest surviving democracy, and is certainly deserving of our recognition," Wales said. "According to our database, that's 212 years older than the Eiffel Tower, 347 years older than the earliest-known woolly-mammoth fossil, and a full 493 years older than the microwave oven."

Encounter Numbers in the Context of Arguments > Context of Math Problems.

In U.S. Name Count, Garcias Are Catching Up With Joneses

Search a list of the 5,000 most common surnames in the United States, according to a new analysis released by the Census Bureau.

SEARCH

1	SMITH	881	1	-
2	JOHNSON			
3	WILLIAMS			
4	BROWN			
5	JONES			

Source: U.S. Census Bureau

By SAM ROBERTS
Published: November 17, 2007

Step aside Moore and Taylor. Welcome Garcia and Rodriguez.

Smith remains the most common surname in the United States, according to a new analysis released yesterday by the Census Bureau. But for the first time, two Hispanic surnames — Garcia and Rodriguez — are among the top 10 most common in the nation, and Martinez nearly edged out Wilson for 10th place.

SIGN IN TO E-MAIL OR SAVE THIS
PRINT
REPRINTS
SHARE

ARTICLE TOOLS SPONSORED BY
THE SAVAGES

The New York Times
nytimes.com

April 10, 2008, 10:51 am

A New Risk of Middle Age: Dying on a Motorcycle

(Richard Perry/The New York Times)

Although the motorcycle has long been associated with youthful rebellion, a new analysis of federal accident data shows that dying on a motorcycle is becoming a middle-aged phenomenon.

Teenage Birth Rate Rises for First Time Since '91

By GARDINER HARRIS
Published: December 6, 2007

U.N. Agency Denies Inflating Cases of H.I.V. Deliberately

By DONALD G. McNEIL Jr.
Published: November 21, 2007

Study Quantifies Orphanage Link to I.Q.

By BENEDICT CAREY
Published: December 21, 2007

Psychologists have long believed that growing up in an institution like an orphanage stunts children's mental development but have never had direct evidence to back it up.

Related
Web Link
Cognitive Recovery in Socially Deprived Young Children: The Bucharest Early Intervention Project (Science)

Now they do, from an extraordinary years-long experiment in Romania that compared the effects of foster care with those of institutional child-rearing.

The study, being published on Friday in the journal Science, found that toddlers placed in foster families developed significantly higher I.Q.'s by age 4, on average, than peers who spent those years in an orphanage.

SIGN IN TO E-MAIL OR SAVE THIS
PRINT
REPRINTS
SHARE

ARTICLE TOOLS SPONSORED BY
THE SAVAGES

Cellphones Challenge Poll Sampling

By MEGAN THEE
Published: December 7, 2007

Study Shows Marathons Aren't Likely to Kill You

By GINA KOLATA
Published: December 21, 2007

Worried about dropping dead if you run a marathon? Researchers in Canada say you can put your mind at ease. The risk of dying on a marathon course is twice as high if you drive it than if you run it, they find.

In fact, they conclude, marathons may actually save lives: more people would die in traffic accidents if the race course had not been closed to vehicles on marathon day. (Nor was there any spillover of extra deaths on alternative routes.) Their paper is being published Friday in The British Medical Journal.

SIGN IN TO E-MAIL OR SAVE THIS
PRINT
REPRINTS
SHARE

ARTICLE TOOLS SPONSORED BY
JUNO
NOW PLAYING

ECONOMIC SCENE

Fearing Red Herring in the Data

By DAVID LEONHARDT
Published: May 14, 2008

Only a month ago, a recession looked inevitable. Job cuts were picking up speed, and stock prices were falling. The Federal Reserve was cutting its benchmark interest rate rapidly, in an effort to keep the downturn from snowballing. But the notion that the economy could avoid a recession altogether seemed fanciful.

StarTribune.com | MINNEAPOLIS - ST. PAUL, MINNESOTA

Stopping teen deaths on the road

By Curt Brown, Star Tribune
February 17, 2008

PRINCETON, MINN.

First, there was JoBeth. Then Tayler, Jon, Victoria, Jordain, Brian and Jonathan.

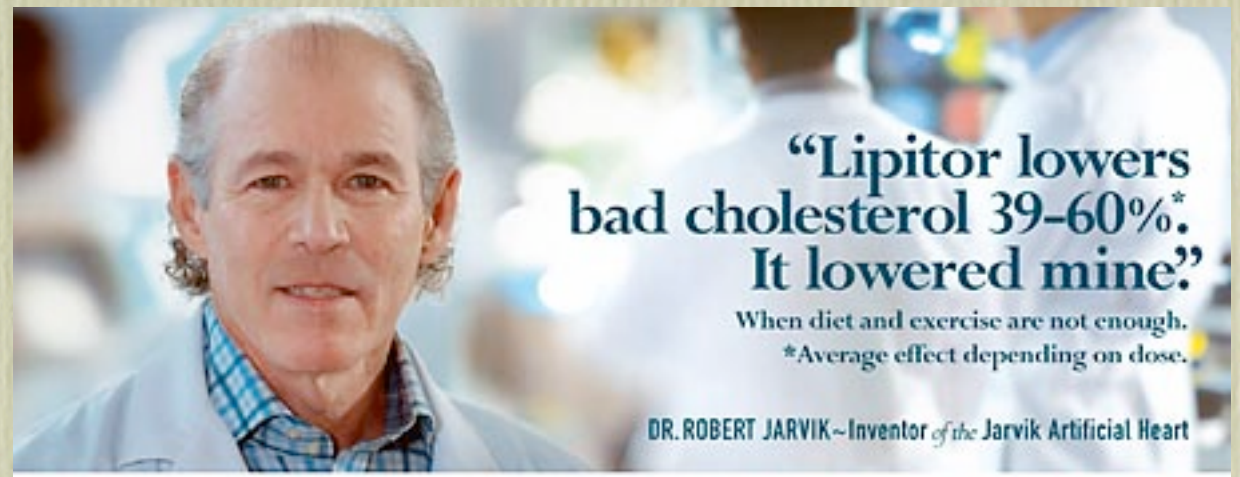
Sami Wilson, a 17-year-old senior at Princeton High School, has attended seven friends' funerals the past two years. All died in teenage driving crashes.

"You kind of just get used to the feeling of a funeral around here," Wilson said the other day, after vehicles in the school's parking lot dispersed with engines revving and cell phones illegally flipping open.

No state in the country has a higher percentage of teenagers behind the wheel in deadly crashes than Minnesota. The deaths have attracted the attention of some legislators, who want changes in state laws, and from teens who are doing something they seldom do: They're asking for more restrictions on their driving to curb the carnage.

"Every year, 18% of the teenagers in Minnesota are killed in traffic accidents."

According to the U.S. Department of Transportation, teens were driving in 18.4 percent of Minnesota's fatal traffic accidents from 2004 to 2006. The national average was 14.3 percent.



And I take Lipitor because it does even more than lower my cholesterol.

- Unlike some cholesterol-lowering medicines, Lipitor is approved by the FDA to reduce the risk of heart

IMPORTANT INFORMATION: LIPITOR is a prescription drug. It is used in patients with multiple risk factors for heart disease such as family history, high blood pressure, age, low HDL ("good" cholesterol) or smoking to reduce the risk of heart attack, stroke and certain kinds of heart surgery. When diet and exercise alone are not enough, LIPITOR is used along with a low-fat diet and exercise to lower cholesterol.

LIPITOR is not for everyone. It is not for those

Qwest Broadband Challenge™

72% of Internet users in the Broadband Challenge picked **Qwest as fast or faster** than Comcast Internet.

Comparing Qwest Platinum to Comcast Performance

"I was really amazed Qwest was quicker."

- Rob S.

TESTIMONIAL LIST

VIEW THE TV SPOT

"When I did the test, I thought Qwest was faster."
- Annette

"This assessment was an eye opening experience."
- Justin

"I was really amazed Qwest was quicker."
- Rob S.

RESEARCH

ORDER NOW

Find out why Qwest Connect® Platinum was chosen **as fast or faster than Comcast** Internet!

Try Qwest® Broadband and get **ONE MONTH FREE!**

Keep your Price for Life

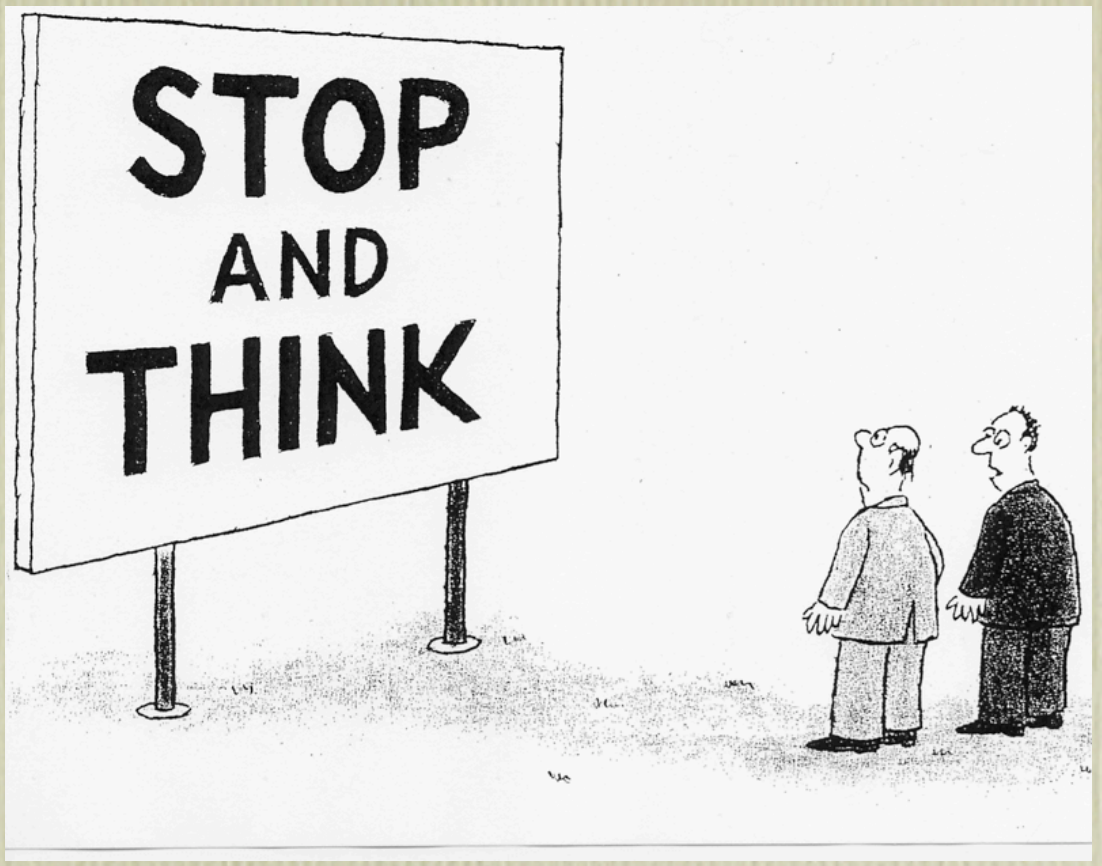
Limited-time offer – order online now!

Enter Qwest Home phone number to Check Availability.

GO

No Qwest Number? Check by Address

* Price for Life available to residential Qwest Connect Silver or Platinum subscribers with a 2-year term commitment. Free month offer available to new or upgrading residential Qwest Connect Silver or Platinum subscribers with a 2-year commitment. Other restrictions apply. See complete details. Offer ends 6/30/07



"It sort of makes you stop and think, doesn't it?"

- *Encounter Numbers in the Context of Arguments > Context of Math Problems.*

- *Find Research > Collect (and Analyze) Data.*

"First they do an on-line search."

- *Encounter Numbers in the Context of Arguments > Context of Math Problems.*
- *Find Research > Collect (and Analyze) Data.*
- *Understand Methods and Literatures > Operate on Numbers.*

The New York Times
nytimes.com

November 3, 2007

Maker of Lipitor Digs In to Fight Generic Rival

By STEPHANIE SAUL and ALEX BERENSON

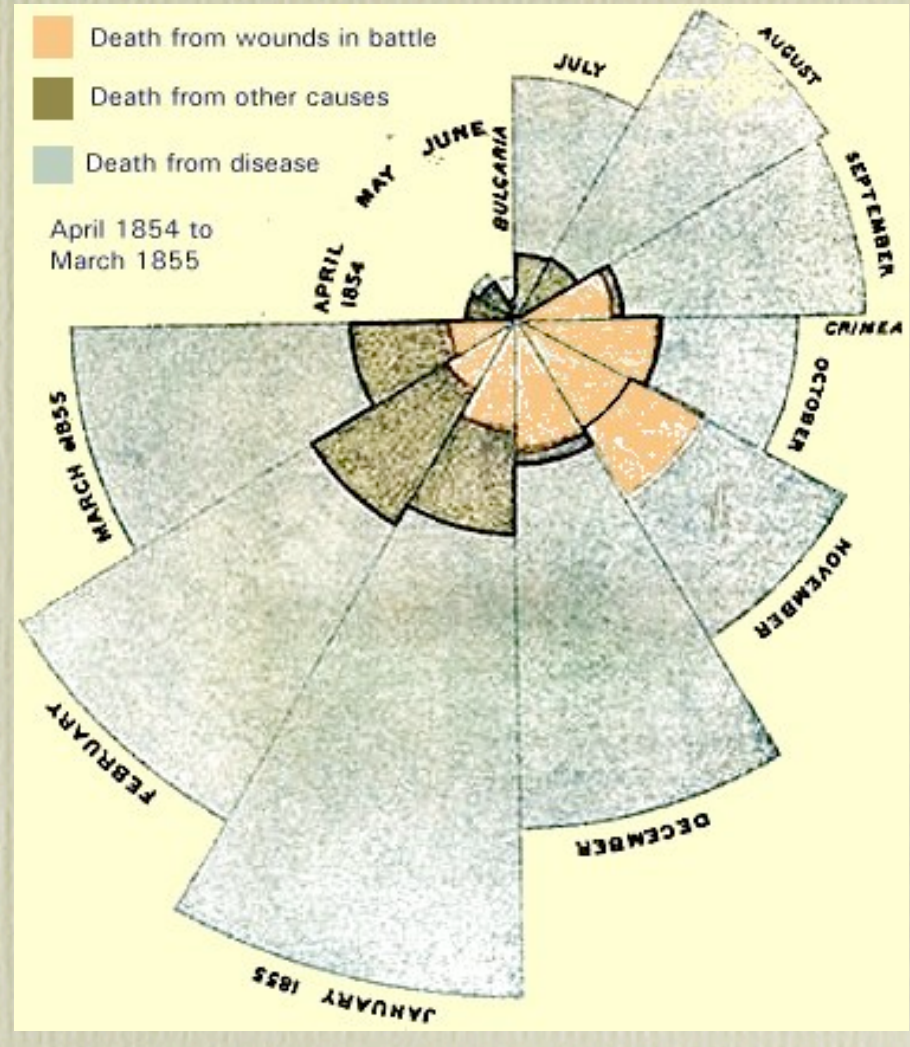
What quantitative concepts would a reader need to know in order to make sense of this important article?

* Know to Read to the end of the article!
* Recognize the strengths of a *Random* clinical trial vs. Case Method.
* Understand Statistical Significance.
* Appreciate the difference between a Single study vs. a Literature.

- *Encounter Numbers in the Context of Arguments > Context of Math Problems.*
- *Find Research > Collect (and Analyze) Data.*
- *Understand Methods and Literatures > Operate on Numbers.*
- *[If in a profession] Need Evidence > Assume Self-Evidence.*

"I just think you're going to need a better rallying cry than 'Absence of evidence isn't evidence of absence.'"

Florence Nightingale,



Cohen (2005), *The Triumph of Numbers,*
pp . 158-177.

II. QR is less about *the manipulation of numbers* than it is about *the evaluation and construction of arguments*.

“...numbers [are] the principal language of public argument.”

More or Less, BBC News Programme

Numbers in
the
evaluation of
arguments:

10 QR Questions at the Ready

10 QR Questions at the Ready:

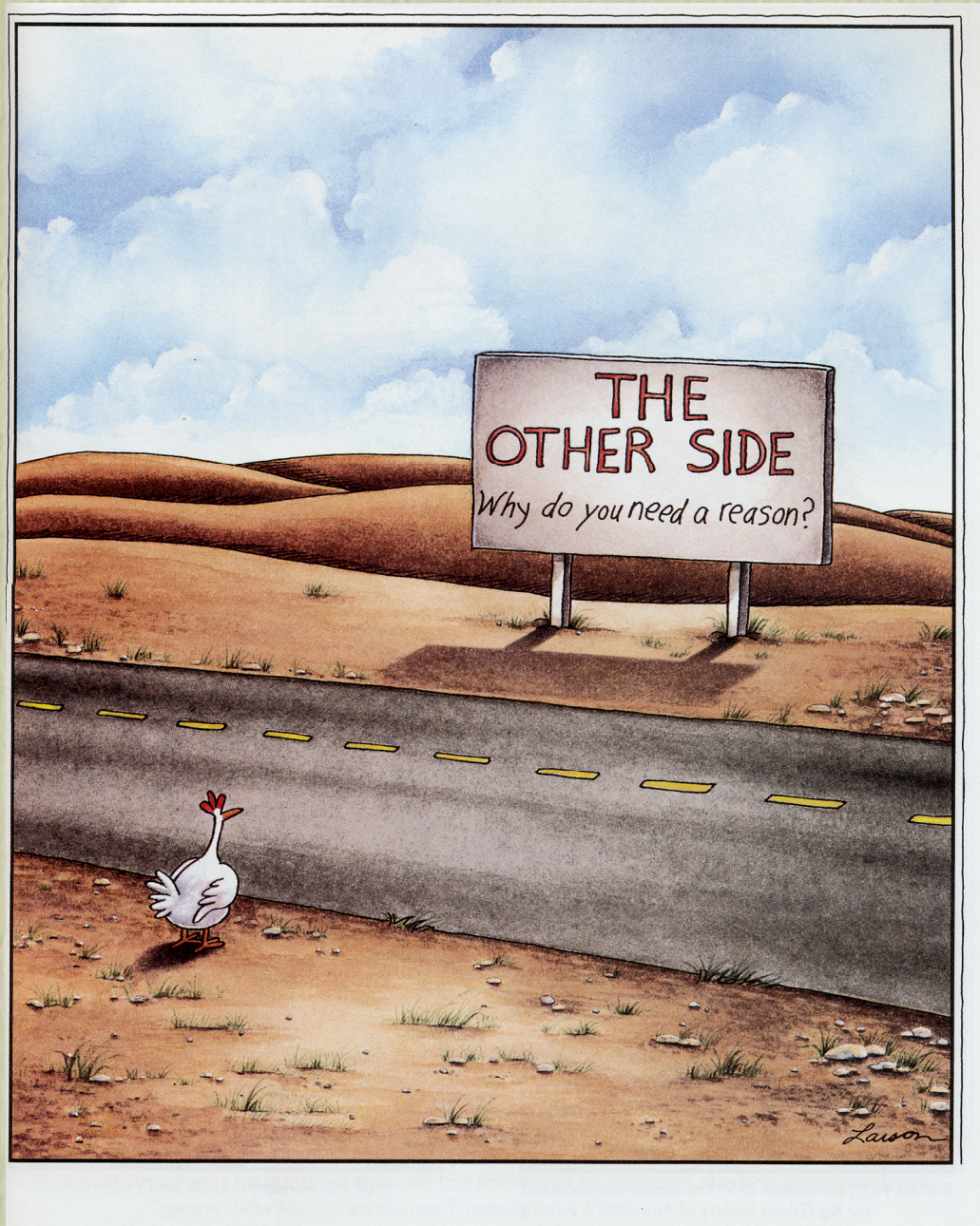
- What do the numbers show?
- How representative is that?
- Compared to what?
- Is the outcome statistically significant?
- What's the effect size?
- Are the results those of a single study or of a literature?
- What's the research design (correlational or experimental)?
- How was the variable operationalized?
- Who's in the measurement sample?
- Controlling for what?

GAISE College Report:

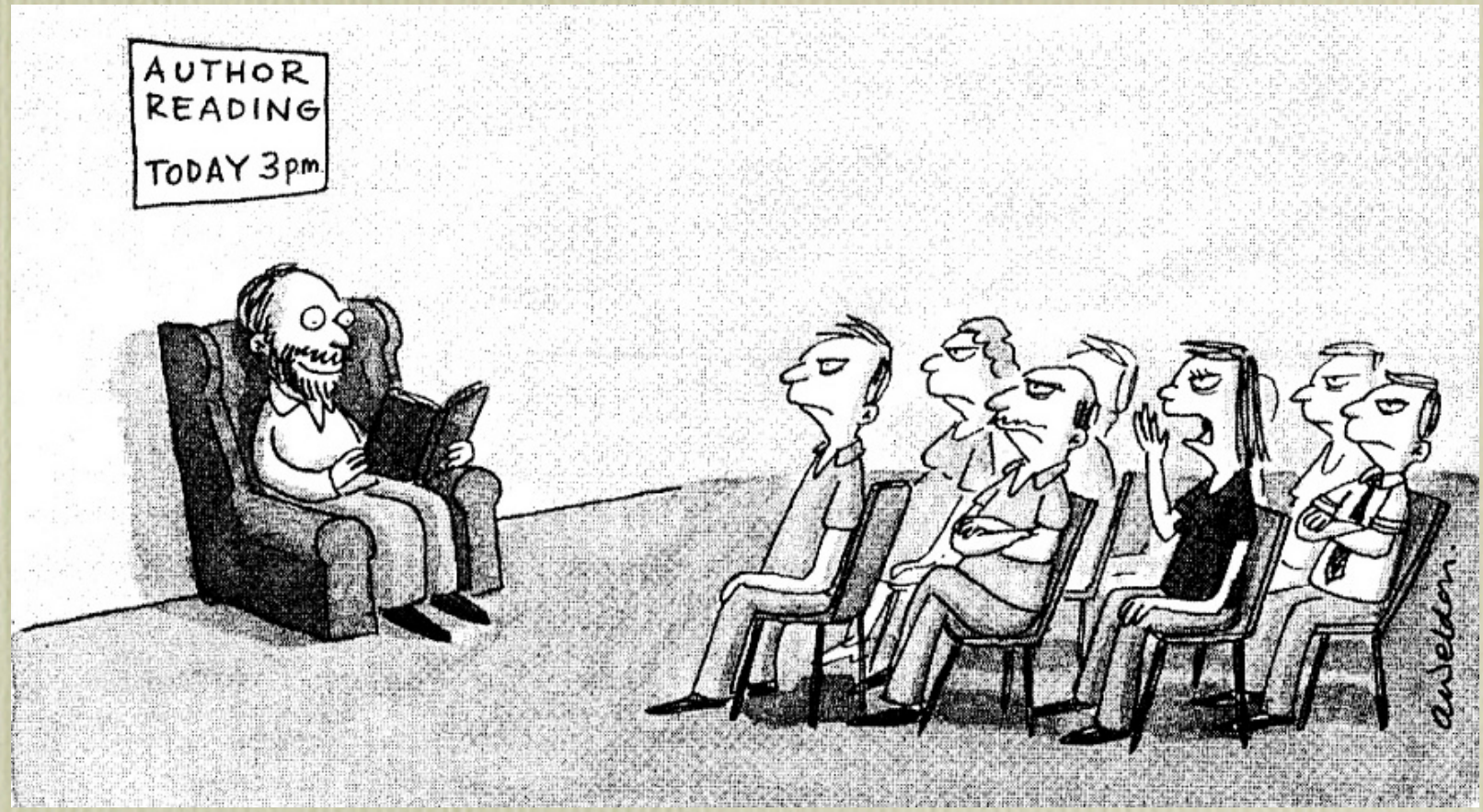
http://www.amstat.org/education/gaise/

- Data beat anecdotes.
- Association is not causation.
- Random sampling.
- Random assignment.
- Statistical significance.
- How to critique news stories and journal articles that include statistical information, including identifying what's missing in the presentation and flaws in the studies or methods used to generate the information.
- When to call for help from a statistician.

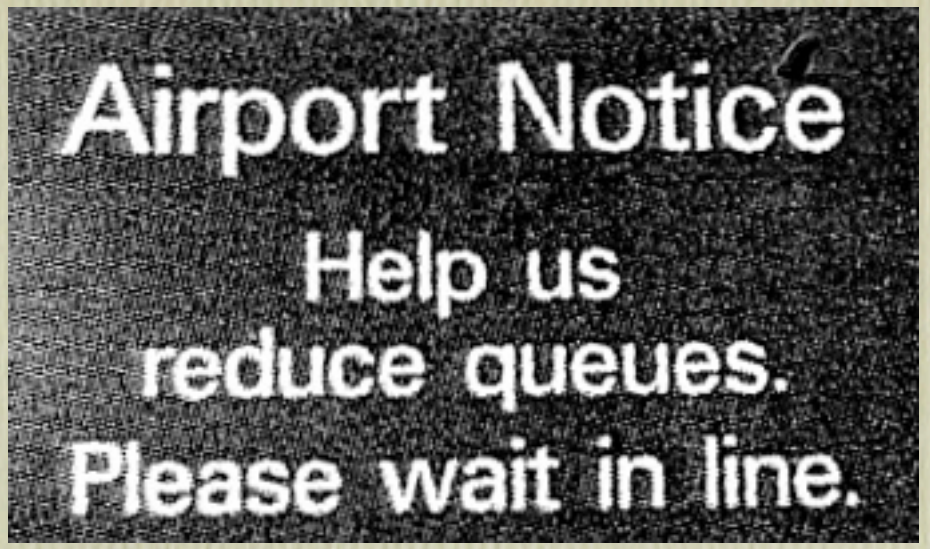
Numbers in the construction of arguments:



Mel Bochner, *Lazy*



"Aloud!"


Airport Notice
Help us
reduce queues.
Please wait in line.

Numbers can help students:

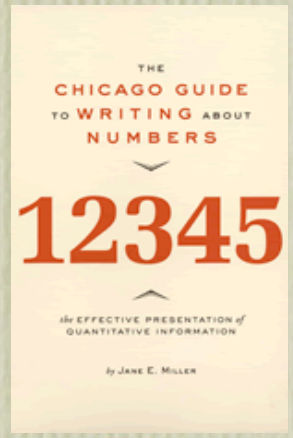
- articulate their ideas.
- express themselves with precision.
- ground their observations in evidence.
- test claims and hypotheses.
- participate in civil discourse.
- represent what they are ill-equipped to see.
- recognize and weigh uncertainty.
- construct a context to attract interest and to inform critical thinking.

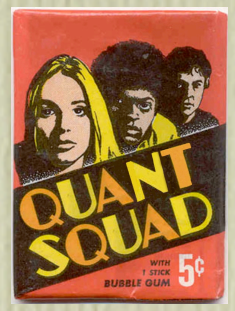
Numbers can help students:

- articulate their ideas.
- express themselves with precision.
- ground their observations in evidence.
- test claims and hypotheses.
- participate in civil discourse.
- represent what they are ill-equipped to see.
- recognize and weigh uncertainty.
- construct a context to attract interest and to inform critical thinking.

"Even for works that are not inherently quantitative, one or two numeric facts can help convey the importance or context of your topic."

-Jane Miller, *The Chicago Guide to Writing about Numbers*





The Quant Squad @ Carleton:

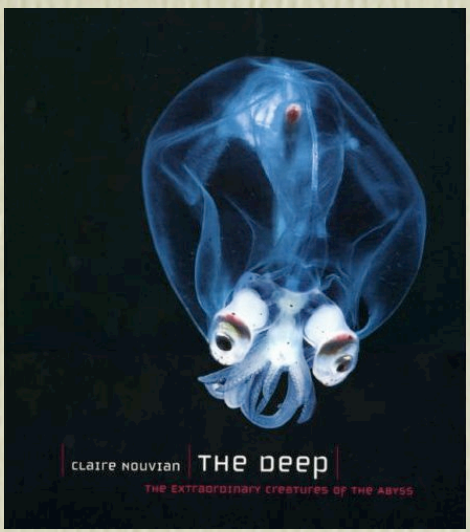
- Randomly sampled papers from student writing portfolios.
- Developed a coding protocol for assessing *QR* in written student arguments.
- Coded the potential relevance of *QR* as central, peripheral, or incidental/irrelevant.
- Rated the degree to which *QR* in fact employed, implemented competently, communicated clearly, and interpreted effectively.

Opening of a paper on *Chronic and Psychogenic Pain*:

"At one time or another, some of us have gone to see a physician for pain treatment only to be told, 'It's all in your head.' Many people experience acute or chronic pain whose severity, duration, or degree of resulting disability cannot be explained by a possible, underlying physical disorder alone. Others suffer psychogenic pain..."

- Only the uppermost part of the oceans--the top two hundred meters--bears any resemblance to the sunlit waters we are familiar with, yet below that zone lies the largest habitat on Earth.
- Ninety percent of all the ocean's water lies below two hundred meters, and its volume is eleven times greater than that of all of the land above the sea...
- Below six thousand meters lies a region known as the hadal zone...; in the Marianas Trench off the Philippines it is 11,000 meters deep. Ships plying the waters over the trench glide as far above the Earth's surface as do jet aircraft crossing the face of America.

-from a review by Tim Flannery of
Claire Nouvian's *The Deep*,
The New York Review of Books, 12/20/07.



and we can help studen ts argue with numbe rs

Ramage, Bean, & Johnson,
Writing Arguments

- *Sufficiency.*
- *Typicality.*
- *Accuracy.*
- *Relevance.*

II. Thinking about QR in terms of arguments has implications for what we teach when we address QR, who teaches QR, and the forms QR programs take.

Literacies @ the curriculum:

*"...**authentic and enduring learning... can rarely succeed one course at a time**. The entire institution must be oriented toward these principles, and the principles must be consistently and regularly employed throughout each course and experience in a program."*

-Lee Shulman (1997)

*"...**numeracy is not something mastered in a single course**. The ability to apply quantitative methods to real-world problems requires a faculty and an insight and intuition that can be developed only through repeated practice. Thus quantitative material needs to permeate the curriculum..."*

-Derek Bok (2006)

Illuminating Arguments with the Power of Numbers

"You know what I like about power? It's so damn empowering."

"...we teachers do not automatically deserve a future. We must earn it by the skill with which we disorient our students, energize them, and inculcate in them a taste for the hard disciplines of seeing and thinking."

-James O'Donnell, *Avatars of the Word: From Papyrus to Cyberspace.*