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.
20 x 16 x 10 = ?
"Just how many pairs of earrings will you actually need on this voyage?" snapped the first mate.
“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!
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.
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.

"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.

A New Risk of Middle Age: Dying on a Motorcycle

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.

Study Shows Marathons Aren’t Likely to Kill You

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.

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

Study Quantifies Orphanage Link to I.Q.

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.

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 children placed in foster families developed significantly higher I.Q.s by age 4, on average, than peers who spent those years in an orphanage.

ECONOMIC SCENE

Fearing Red Herring in the Data

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.
“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 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...
“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.
**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,

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
• 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?
• 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.

GAISE College Report:
http://www.amstat.org/education/gaise/
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.
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“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*
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.
and we can help students argue with numbers.

- 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.
“...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.”