Illuminating Arguments with the Power of Numbers

Neil Lutsky
Carleton College
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:

Senility

Youth

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

“It appears to be some kind of wireless technology.”
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!
“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.
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.
“Every year, 18% of the teenagers in Minnesota are killed in traffic accidents.”
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.
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 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 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*
• 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.

The Quant Squad @ Carleton:
“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.
we can help students argue with numbers 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)
“...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.”