

11 July 2005 TOC Summer Seminar 1

Statistical Literacy and Critical Thinking

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Union College
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www.StatLit.org/pdf/2005SchieldTOC6Up.pdf

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Statistical LITERACY

Focuses on Social Arguments

Florence Nightingale

“Seven times as many died after the battle as died in the battle.”

Nurses save lives;
We need more nurses!



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Statistical Literacy

*To be literate about everyday arguments
that use statistics as evidence*

Statistics are man-made, socially constructed.
Motto: **“Take CARE!”**

- C = Confounding (Predictors tangled up)
- A = Assembly (Define/Choose/Present)
- R = Randomness (Chance)
- E = Error or Bias (Mistakes, Sampling bias)

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Thesis

Statistics are not just numbers: 3 times 2 = 6.

Statistics are counts, measures of real things: things that are classified using concepts.

- “40% of kids are involved in bullying.”
- “Depression is the #1 cause of suicide”

Statistical literacy is applied critical thinking.
A useful admonition: *“Check your premises.”*

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Assembly: Lies vs. Prevarication

“Lies, Damned Lies and Statistics.”

Lying is dumb. If you get caught, you look stupid.

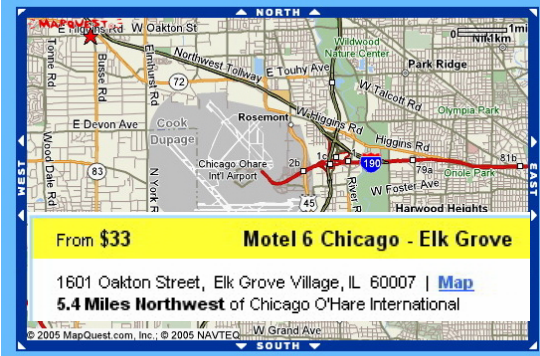
Children & adults learn to prevaricate: to straddle, to equivocate, to omit, to tell a half-truth.

Prevarication is not lying.

Prevarication can be

- * deliberate and even malicious.
- * unintentional – result of ignorance or enthusiasm.

Hotel address: 1601 Oakton Street, Elk Grove Village, IL 60007



From \$33 **Motel 6 Chicago - Elk Grove**

1601 Oakton Street, Elk Grove Village, IL 60007 | [Map](#)
5.4 Miles Northwest of Chicago O'Hare International

Area airports
O'hare International Airport 8.6 miles, Palwaukee Municipal Airport 10.4 miles, and Midway Airport 23.9 miles.

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Assembly: Average or Typical Family

1999 US Households	Mean Income	Median Income
Before tax	\$55K	\$41K
After tax	\$41K	\$34K
Tax Paid	\$14K	\$7K


Q. How much tax is paid by the **average** family?
Q. How much tax is paid by a **typical** family?

\$55K: Before-tax US household mean income
\$34K: After-tax US household median income
Look at that **\$21K difference due to taxes...** ☺

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Everyday Prevarication: "99.9% Accurate"

- Greater Than 99.9% Accurate
Reliable as Tests Used by Doctors and Hospitals
- Confidential and Anonymous
- Results 24 Hours a Day
- One Spot™ Technology



HIV-1 TEST SYSTEM
for the Detection of Antibodies to HIV-1

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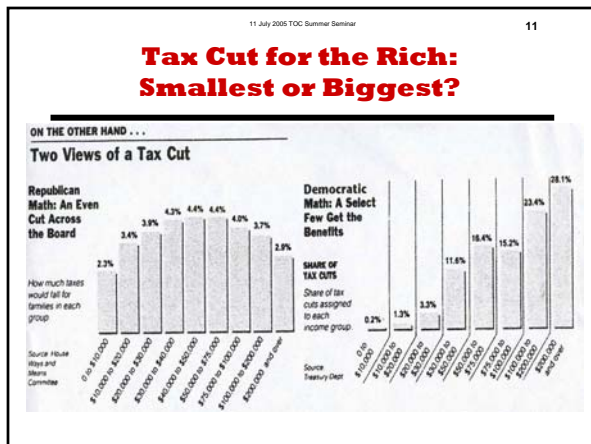
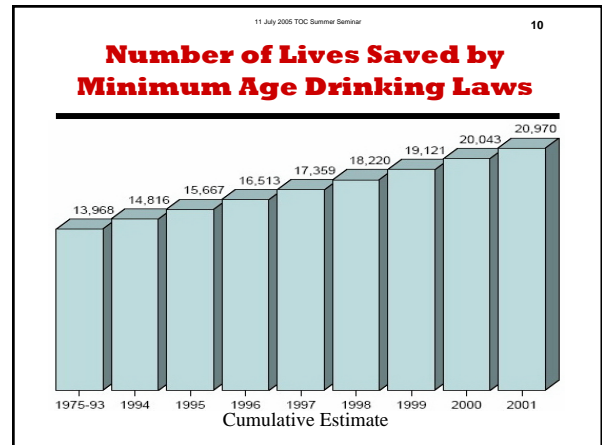
Prevaricating with "Accuracy"

Accuracy in Confirmation:
99.9% of those who have HIV test positive.

Accuracy in Prediction: If 0.1% have HIV
50% of those who test positive have HIV.

- Greater Than 99.9% Accurate
Reliable as Tests Used by Doctors and Hospitals

HIV-1 TEST



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Borderline Prevarication: Twice as Many Marriages



1 site for love

"twice as many marriages as any other site in the world."



How could this reflect poorly on match.com?

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Assembly & Context

Auto death rate in Hawaii vs. Arkansas

- higher per mile of road
- lower per vehicle

Divorced men 35-44 are most likely to marry...

- than any other age-group of divorced men.
- than divorced women 35-44.
- than non-divorced men 35-44.

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Different Emphasis

Confounding: Predictors are tangled up.

- ‘Take control of’ by random assignment.
- ‘Control for’ by standardizing (regression).

Assembly:

- defining groups (bullying, heat-wave deaths)
- choosing statistics (centers, rates, percents)
- presenting statistics (graphs & comparisons).

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Context: Four Core Concepts

Here are four common techniques for taking into account the influence of context.

Four key math tools that control for context:

1. Arithmetic comparisons (% more than)
2. Ratios (percentages, rates, probability)
3. Comparisons of ratios (likely, prevalent)
4. **Standardizing (compare apples w. apples)**

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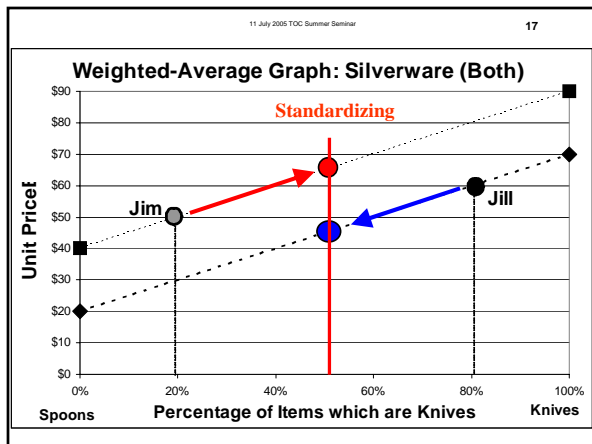
Context: Standardizing

Once you have ratios (percentages, rates or averages) or comparisons of ratios, many students mistakenly think no more can be done.

Standardizing takes into account the influence of confounders on ratios.

Standardizing links mathematics, confounding and context in ways that everyone should know.

Standardizing involves multivariate thinking.



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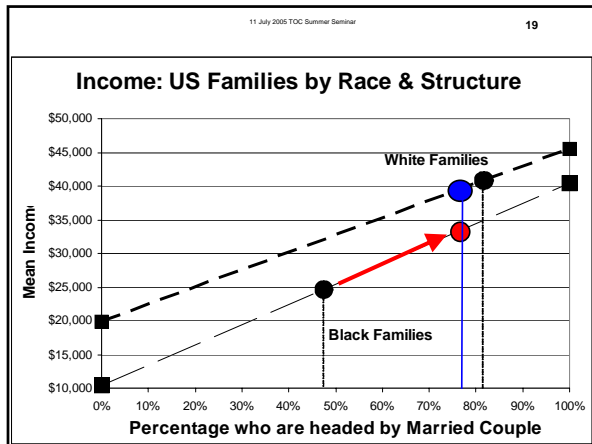
Numbers in Context: Multivariate Thinking

Let's try an example in Public Affairs:

Average family income:

- \$41,000 for US white families
- \$25,000 for US black families
- \$16,000 is the black-white income gap

Is this evidence of structural racism in America?



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Numbers in Context: Seeing Confounding

Mexico has better medical care than the US.

- Death rate in Mexico: 5 per 1,000 population
- Death rate in US: 8.7 per 1,000 population

Utah schools (227) better than Oklahoma (225)

NAEP score: 4th grade Math in 2000n.
 OK higher than UT for low-income kids & for high-income kids. OK had more low-income kids

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Statistical Literacy: Thinking about Essentials

Deductive logic is no longer required.
 Critical thinking is

- Nebulous & may be considered remedial
- No disciplinary home
- Not a core element in general education

Statistical Literacy is recognized as a needed skill for all college graduates.

Statistical Literacy => Conceptual Literacy


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Statistical Literacy

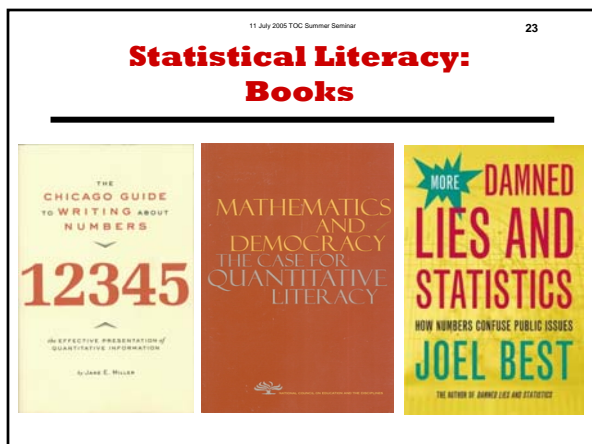
Dr. David Kelley, Philosopher

Author of “The Art of Reasoning”

“There are few tasks in education today as urgent as improving the quality of statistical literacy.”



Featured in an ABC John Stossel video



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Recent Articles at www.Augsburg.edu/StatLit

Schild, Milo (2004). *Statistical Literacy and Liberal Education at Augsburg College*. AAC&U Peer Review

Schild, Milo (2005). *Information Literacy, Statistical Literacy and Data Literacy*. IASSIST IQ Quarterly.

Schild, Milo (2005). *Statistical Prevarication: Telling Half Truths Using Statistics*. IASE conference Sydney

Schild, Milo (2005). *Statistical Literacy: An Evangelical Calling for Statistical Educators*. ISI Au.

Terwilliger, Jim and Milo Schild (2004). *Frequency of Simpson’s Paradox in NAEP Data*. AERA