# Statistical Literacy and Critical Thinking

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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!



2 July 2005 TOC Summer Semina

### **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)

### 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."

### 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.





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... ©



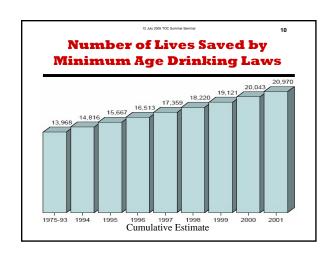
Prevaricating with "Accuracy"

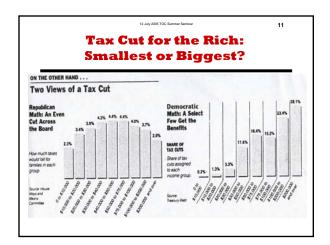
Accuracy in Confirmation:
99.9% of those who have HIV test positive.

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 - ITEST







**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.

**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).

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)

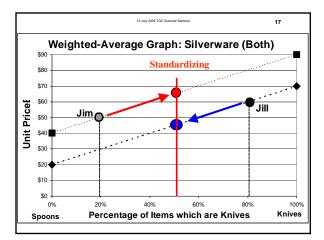
Context:
Standardizing

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.



#### Numbers in Context: Multivariate Thinking

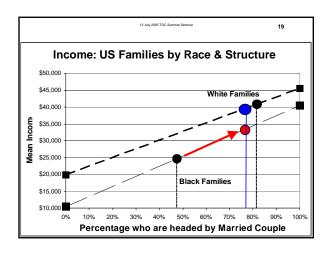
Let's try an example in Public Affairs:

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?

Statistical Literacy



#### 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

#### 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** 

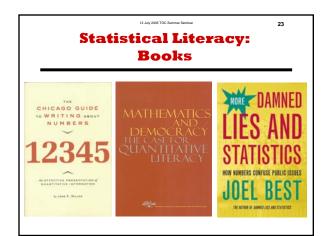
## Statistical Literacy Dr. David Kelley, Philosopher

## 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





## Recent Articles at

www.Augsburg.edu/StatLit

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

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

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

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

Terwilliger, Jim and Milo Schield (2004). Frequency of Simpson's Paradox in NAEP Data. AERA