

August 2011 IASE 1

All Statistics are Socially Constructed

MILO SCHIELD,
Augsburg College

*US Rep: International Statistical Literacy Project
VP National Numeracy Network
Webmaster [www. StatLit.org](http://www.StatLit.org)*

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Statistical Literacy courses: The Next Big Thing?

2009: Survey of all US four-year colleges found that 19% of respondents offered a statistical literacy course.

2010: Wired Magazine said, "*Statistical literacy: A course you should have taken in college.*"

2011: US Supreme Court finds statistical significance is not necessary for causation.

2011: Eight college faculty completed the Augsburg College statistical-literacy teacher-training course online. These teachers analyzed 14 news stories.

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#1 All Statistics are Socially Constructed

"All statistics, from the best to the worst, are socially constructed.

All statistics are products of choices and compromises that inevitably shape, limit, and distort the outcome."

Joel Best (2002)

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#2 Four Kinds of Influence on Statistics Take CARE

Context: Influence of factors that were – and were not – taken into account (multivariate analysis)

Assembly: Influence of choices in defining, measuring, comparing and presenting statistics

Randomness: Influence of chance based on choices in type and size of sample

Error (Bias): Influence of factors generating systematic differences between observed and reality.

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Statistical-Inference Courses Cover Randomness and Error

Statistical educators generally teach that statistics can be influenced by human choices:

Randomness: size and type of sample (random vs. convenience), sampling distribution, etc.

Error/bias: Choices that produce *subject-response bias, measurement bias and sampling bias*. E.g., the target population, the sampled population, the sampling method, the handling of non-responses

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#3. Statistics Are Influenced by "Context"

Statistical educators agree that statistics are numbers in context, but they don't generally teach that statistics can be influenced by human choices involving "context": choices in

- what to take into account using tables, series, ratios, comparisons and comparisons of ratios
- how to model data
- what factors not taken into account (potential confounders)

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Hyatt: Close to the US Capital



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Loudest Animal on Earth



Pond insect 'loudest animal on Earth'

A tiny 'water boatman' insect is the world's loudest animal relative to its body size, according to a new study.

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Two Per Cent Milk



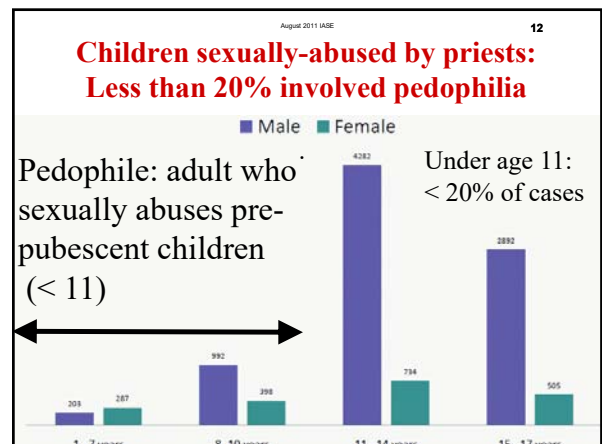
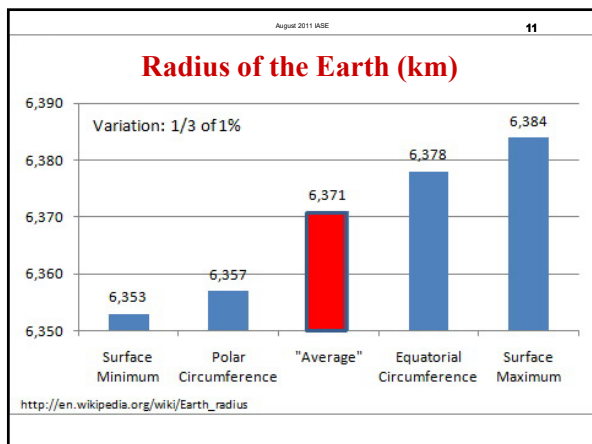
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#4 Statistics are Influenced by "Assembly"

Statistical educators don't generally teach that statistics can be influenced by human choices in "Assembly": choices in

- definitions of groups/measures*
- comparisons (# more vs. % more)
- presentation (pie chart vs. bar graph)

* aside from mean vs. median...



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Pure Assembly!!

ON TEENAGERS, ADULT:

Statistics show that teen pregnancy drops off significantly after age 25.

Mary Anne Tebeño, Republican state senator from Colorado Springs (contributed by Harry F. Panter)

MONDAY DECEMBER 1999

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How to Teach Context and Assembly?

Must involve problems that can be assessed.

Augsburg's Statistical Literacy course has created:

- over 300 involving *Context*
- over 100 exercises involving *Assembly*

Consider ways to teach assembly using definitions

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**Definitions of statistics
Can be Classified on a Spectrum**

Two Extremes for Comparisons:

Formal: Need no knowledge of ideas

- Fewer tall smokers than smokers...

Material: Need detailed knowledge of ideas

- More autistic boys than autistic girls...

In between: Need some knowledge of ideas

- Men are taller than women on average.
- Women live longer than men on average.

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Statistical educators should teach definitions as part of study design

- **Should teach formal comparisons of operational definitions.** Little knowledge of ideas is needed. Like logic/math.
- **Might delay teaching material comparisons of operational definitions.** Requires a detailed knowledge of specialized ideas. Leave this to SMEs.
- **Could selectively teach in-between comparisons of operational definitions.** At least show sensitivity of some statistics to small changes in definition.

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**Formal Compare: Operational Definitions
Counts: Criteria-based**

Examples: Which count/total is larger?

- US population; US male population?
- Not employed; Not employed *and* looking for work?
- Use of physical force ; Use *or* threat of physical force?

Principles involving counts or totals:

- *And* phrases and modifiers restrict options – smaller total
- *Or* phrases increase options – larger total

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**Formal Compare: Operational Definitions
Counts: Frequency-based**

Examples: Which count is bigger?

- Smoker: smokes *more than* five cigarettes a day
- Smoker: smokes *more than* two cigarettes a day
- Sober: consume *less than* 3 drinks in past week
- Sober: consume *less than* 1 drink in past week

Principles involving ranges:

- *More than X.* Larger X gives smaller count.
- *Less than X.* Larger X gives bigger count.

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Formal Compare: Operational Definitions
Counts: Duration-based

Examples: Which count is bigger?

- 1a. Smoker: smoked in the past 2 weeks
- 1b. Smoker: smoked in the past 4 weeks
- 2a. Sober: No alcohol in past 2 weeks
- 2b. Sober: No alcohol in past 4 weeks

Principles involving time periods:

- Event in past X periods: Bigger X, bigger number.
- Event-free in past X periods: Bigger X, smaller #.

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Formal Compare: Operational Definitions
Ratios: Compare Numerators

Which ratio is larger in each group?

1. Percentage of US citizens who are adults; who are adult males; who are adults or are males?
2. The US death rate due to suicide; the US death rate; the US death or emigration rate

Principles: Changes in the Numerator:

And phrases and modifiers restrict – smaller ratios
Or phrases increase options – larger ratios

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Between Compare: Operational Definitions
Part-Whole Ratios

General: Minimal knowledge of ideas is needed

Examples: Which ratio is bigger?

1. US birth rate: per 1,000 adults or per 1,000 women?
- 2a. Percentage of US males who are in the military
- 2b. Percentage of the US military who are male
- 3a. Percentage of US oil **imports** that are from OPEC
- 3b. Percentage of US oil **usage** that is from OPEC

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Study Between Operational Definitions:
Part-Whole Ratios

General: Minimal knowledge of ideas is needed

Examples: Which ratio is bigger?

- 1a. Percentage of auto accidents that involve a death
- 1b. Percentage of auto death that involve an accident
- 2a. Accidental death rate per 1,000 US males
- 2b. Male-death rate per 1,000 US accidents
- 3a. Percentage of US adult prisoners who have low IQ
- 3b. Percentage of US low-IQ adults who are in prison

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Recommendation

Statistical educators must go beyond chance and bias in analyzing the influences on a statistic.

We should encourage *critical thinking* about the choices that could have been made in creating statistics and how sensitive the statistics are to those choices.

We should start with the simple question: “*Where do statistics come from?*” Once people realize that all statistics are constructs, socially-constructed tools, then we can teach statistical literacy as a liberal art (an inductive activity) rather than as a mathematical skill.

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References

Joel Best Articles Page: www.StatLit.org/Best.htm

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Schild, Milo (2010). Assessing Statistical Literacy: TAKE CARE in *Assessment Methods in Statistical Education: An International Perspective*. Edited by P. Bidgood, N. Hunt and F. Joliffe. Wiley Publishers, Ch. 11, p. 133-152.