Statistical Literacy: Right-Wrong Assessment

MILO SCHIELD

Augsburg College

Director, W. M. Keck Statistical Literacy Project

www.StatLit.org   **Schield@augsburg.edu**

International Association

of Statistical Educators

Guimarães, Portugal

20 August, 2007

www.StatLit.org/pdf/2007SchieldIASE6Up.pdf

Statistical Literacy: News Articles

The ASA GAISE* College report:

Introductory courses in statistics should strive to:

• *emphasize statistical literacy*

• *stress conceptual understanding*

• *integrate assessments aligned with course goals*

Assess statistical literacy by students *"interpreting or critiquing articles in the news…"*

* Guidelines for Assessment & Instruction in Stat Ed.

The Stat-Lit Problem

Media statistics are selected **summary statistics**.

Readers cannot calculate the influence of
- grouping subgroups in different ways
- choosing the mean versus the median
- choosing $P(A|B)$ instead of $P(B|A)$
- presenting an association as ratio vs. difference

Readers can never calculate the influence of
- changing definitions of groups or measures
- including a plausible confounder

Hypothetical Thinking

To analyze/evaluate the summary statistics in a study, survey or essay, one must be able **to think hypothetically** about *what could have been done*.

Students lack training in hypothetical thinking:

- estimating magnitudes or ranges
- estimating associations or correlations
- comparing the influence of different factors
- distinguishing between plausible and arbitrary.

Assessment Pyramid for Statistical Literacy

·

Analyze summary statistics in the media

Hypothetical Thinking Exercises

Factual (Right-Wrong) Exercises

Multiple choice:
1. Calculate a number
3. Non-math questions

Essay:
2. Write accurate statements that describe/compare ratios

Deductive Thinking 1A: Simple Numeric

Right-wrong drill with a single numeric answer

Pure calculation (to learn the process)

- Calculate Z-score and Effect Size
- Calculate cases attributable to the exposure
- Calculate rates and percentages from counts
- Calculate percentages from related percentages
- Standardize rates for confounder influence
- See if a difference is statistically significant
- See if significance is influenced by confounder

1A: Examples

If the poverty rate is 25% in single-parent homes (4 million); 5% in married-family homes, then how many single-parent families in poverty **are attributable to** being headed by a single-parent?
a) 1 million   b) 800,000   c) 200,000   d) 50,000

If 72% of adults in prison are school dropouts/leavers (12% of all adults) and if 5% of those 14-18 go to prison, what percentage of school drop-outs 14-18 will go to prison? a) 5%   b) 10%   c) 20%   d) 30%

1A: More Examples

·Which is bigger, (a) the percentage of infant deaths which are due to birth defects or (b) the percentage of infants who die due to birth defects?

Which is bigger?   a. P(AB|C)   b. P(A|BC)

How many times must one flip a set of 10 coins so that a set of 10 heads is **more likely than not**?
a) 256   b) 1,024   c) 4,048   d) 8,096

Deductive Thinking 1B: Complex numeric

Bullying: Which definition gives a higher rate?

- use of physical force

- use -- or threat -- of physical force

Which choice of group gives a higher rate?

- bullying among school students years 1 to 12

- bullying among school students years 6 to 8

Deductive Thinking 2: Ordinary English

Students need drill in using ordinary English to describe and compare numbers and ratios.

1. Is 2 four-times less than 8?   Yes or No

2. Do these both say the same thing? Yes or No
   The percentage of women who are runners
   The percentage of women among runners

3. Do these both say the same thing? Yes or No
   Men are more likely to suicide than women
   Men are more likely among suicides than women

Flip a Fair Coin

What is the chance that **a head on 1st try is followed by a head on 2nd**?

a. 0.25   b. 0.50   c. Can't tell

Cual es la probabilidad de **cara en el 1st lanzamiento seguido de cara en el 2° lanzamiento.**

a. 0.25   b. 0.50   c. No se

Which gives the higher rate?

Which is more probable in the next year?
a) a women will give birth
b) a 20-year old woman will give birth
c) can't tell.

Que' es mas probable en el proximo ano?
a) Que una mujer de a luz
b) que una mujer de 20 anos de a luz
c) No se (decir)

Deductive Thinking #3: Non-Math

Students need drill to distinguish:

- *Association* from *causation*
  C.f. Eating nuts cuts cancer prevalence in half.

- *Experiments* from *observational studies*

- *Longitudinal* from *cross-sectional studies*
  What kinds of confounders does each ward off?

- *"percentage attributable to"* (a predictor) from *"percentage explained by"* (a confounder).

Kinds of Exercises by Statistics Topics

Traditional Statistics	Mathematics			
	1	**2**	**3**	**Total**
Critical Thinking		2	16	18	14%
Descriptive	16	3	4	23	18%
Compare #	2	5		7	5%
Rates, %	6	17		23	18%
Likely Compare	5	16		21	16%
Standardizing	20	2		22	17%
Randomness	16			16	12%
Total	65	45	20	130	
	50%	35%	15%	100%	

Mathematics: 1) numerically-based answer,
2) ordinary English answer, 3) non-math question

Kinds of Exercises by Stat Lit Topics

Statistical Literacy	Mathematics				
	1	2	3	Total	
Critical Thinking		2	16	18	14%
Confounding	23	34		57	44%
Assembly	18	6		24	18%
Randomness	23	1	2	26	20%
Error/bias	1	2	2	5	4%
Total	65	45	20	130	100%
	50%	35%	15%	100%	

Mathematics: 1) numerically-based answer,
2) ordinary English answer, 3) non-math question

Next Steps

Evaluate these deductive right-wrong problems to see how well they help students:

• understand key concepts in statistical literacy

• think hypothetically about the selected summary statistics presented in the media.

Develop open-ended, multi-answer problems to help students develop hypothetical thinking.

References

Gal, Iddo (2002). Adult Statistical literacy: Meanings, components, responsibilities. *ISR 70,* 1-25.

Gal, Iddo (2003). *Functional demands of statistical literacy: Ability to read press releases ..* IASE Berlin

Schield, Milo (2007a) *Teaching the Social Construction of Statistics.* Midwest Sociological Association. See www.StatLit.org/pdf/2007SchieldMSS.pdf.

Schield, Milo (2007b). *Factual Assessment to Support Hypothetical Thinking.* IASE Portugal See www.StatLit.org/pdf/2007SchieldIASE.pdf.