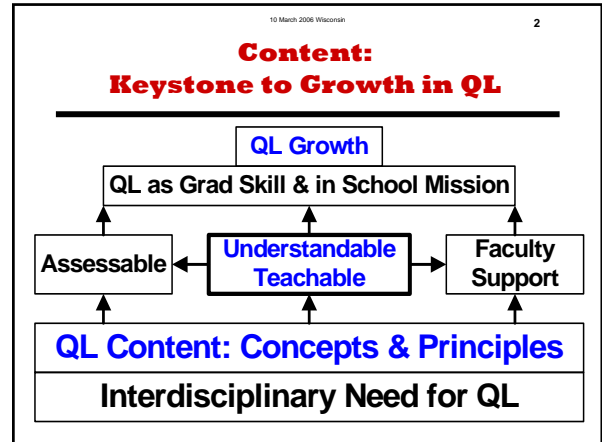


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Statistical Literacy for Majors w/o Math Reqs.

MILO SCHIELD
 Augsburg College
 Director, W. M. Keck Statistical Literacy Project
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Quantitative Literacy Conference
 University of Wisconsin, River Falls Campus
 10 March 2006



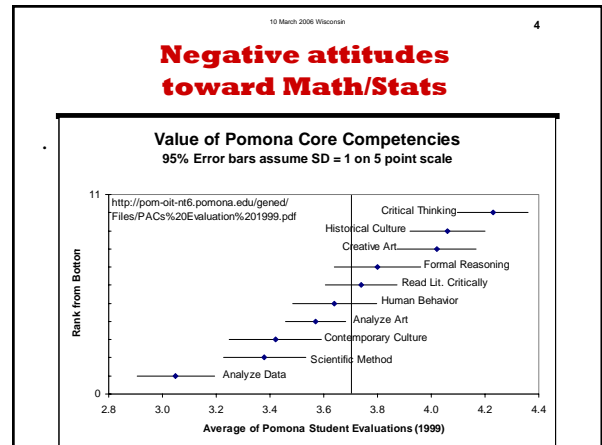
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QL must be Understandable & Teachable

"Because of their education and training, most teachers are not prepared for or comfortable with the mathematics required for quantitative literacy."

"According to Johnny Lott, former president of NCTM, it is simply unrealistic to expect that teachers of other subjects will either know or understand what might be considered quantitative literacy."

"QL advocates need to be very clear about what all students need to know and be able to do, starting with where it fits into the mathematics program."



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Business Student's Perception of Statistics

Percentage of business majors who would Absolutely or Almost Certainly **take Statistics as an Elective**.

Business Students	ALL	Attitude Toward Math	
		Like	Dislike
MAJOR			
ALL	22%	29%	16%
Acc/Fin/Econ/MIS	28%	38%	21%
Mgmt and Mktg	7%	12%	0%

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Q/L Needs Vary by Major

Involves topics students see often in their discipline.

Majors that require a Math/stat course:

- Modeling, significance, discriminating, testing (Need at least algebra if not calculus)

Majors that do not require a Math/stat course:

- Association vs. causation, Construction of groups and measures, Influence of context, bias and randomness. (More emphasis on words than algebra).

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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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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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QL Numbers in Context

"The essence of QL is to use mathematical and logical thinking in context." Lynn Steen 2004

QL must have defining core concepts that are

- based on the role of context in arguments
- mathematically sound
- understandable by all students and faculty
- useful to all students in their everyday lives
- teachable by non-math faculty.

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QL: Four Core Concepts

Whether QL is a separate course or is infused in other courses, it must have core concepts.

Here are some good candidates:
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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#1: Numeric Comparisons Control For Context

Qualitative vs. quantitative

- Napoleon was shorter than many French soldiers
- Napoleon 4" shorter than average French soldier
- Women live longer than men
- Women can expect to live 7 years longer than men

If interest rates increase from 1% to 2%.

- Double (two times as much as)
- 100% increase (100% more; 1 times more than)
- 1 percentage point increase **Not a 1% increase!**

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Simple Arithmetic Comparisons

Three is 2 times [200%] more than One.

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**#2:
Ratios Control For Context**

Part-whole ratios are conditional probabilities.

- $P(B|A)$

Algebra is clean and unambiguous.
 Ordinary English is messy and ambiguous
 But students speak English – not Algebra

Q. Can these both be true for the same group?

1. Unemployment is up Number is up
2. Unemployment is down Rate is down

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**#2
Ratios Control For Context**

Q1. Are these percentages the same?

1. The percentage of men **WHO ARE** runners
2. The percentage of men **AMONG** runners

Q2. Are these rates the same?

3. The women's death rate
4. The death rate of women
5. The rate of death among women
6. The women's rate of death

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**Q/L: Interpreting Medical Tests
99.9% accurate!**

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**“99.9% Accurate”
Statistical Prevarication:**

Q. Is this accuracy in prediction?

- 99.9% of those testing positive have HIV?
NO!

“99.9%” involves confirmation, not prediction

Confirmation:

- Of those with HIV, 99.9% test positive

Prediction is typically a different number:
 Suppose that 0.1% of a population have HIV.
 50% of those testing positive, will have HIV

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**#3: Comparisons of Ratios
Control For Context Two Ways**

Is marijuana a gateway drug to heroin?

1. 90% of heroin addicts first used marijuana
2. 99% of heroin addicts first used milk

Are men psychologically stronger than women?

3. Widows are more likely **AMONG** suicides than widowers [are].
4. Widows are *less* likely **TO** commit suicide than widowers [are].

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**Augsburg StatLit Project:
Web-based Tools**

Simple Surveys: www.StatLit.org/Survey

Grammar Checker: www.StatLit.org/GC

User Goal: To help students **read** a table of rates and percentages, **decode** the meaning, and **write** a single sentence in ordinary English that describes a single ratio or compares two ratios.

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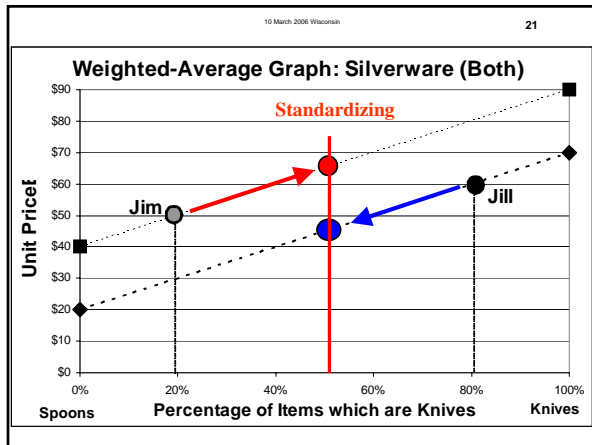
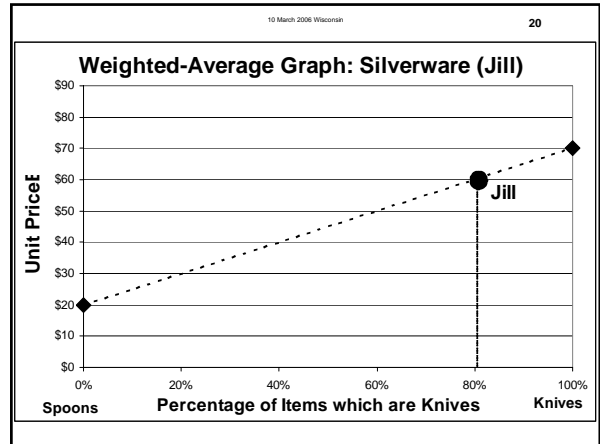
#4: Standardizing Ratios Controls For Context

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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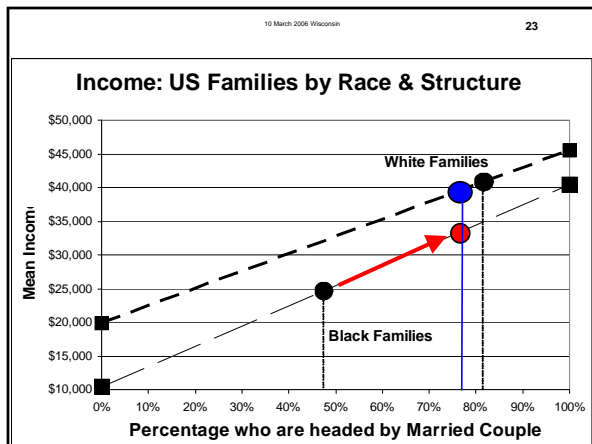
#4: Numbers in Context: Multivariate Thinking

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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#4: 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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Quantitative Literacy
Gina Kolata, NY Times

Beyond arithmetic and geometry, *quantitative literacy* also requires logic, data analysis and probability...

It enables individuals to analyze evidence, to read graphs, to understand logical arguments, to detect logical fallacies, to understand evidence and to evaluate risks.

Quantitative literacy means **how to reason** and **how to think**.

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Numbers in Context
Take "CARE"

Associations have many explanations:
Causation [of outcome by predictor]

- **C**onfounding (may be a common cause)
- **A**ssembly (people choose the stats presented)
- **R**andomness (more likely in small samples)
- **E**rror/Bias (sampling bias, subject bias, etc.)

To support causation, one must be able to eliminate alternate explanations (CARE).

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QL Has a Bright Future

If QL can agree on some core QL ideas that

- are common across the curriculum,
- focus on arguments in everyday life,
- relate to context, and
- enhance students' critical thinking

then Quantitative Literacy will be **valued, respected and accepted** in academia.

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Students support Statistical Literacy

Goal: Students to appreciate the power of math/stats in their discipline.

Statistical literacy studies arguments found in the news everyday that use statistics as evidence.

Students support statistical literacy:

- Capella students ranked Stat Lit 2nd out of 15 Gen. Ed. course in promoting critical thinking.
- 57% of Augsburg students agreed that it should be "required for graduation for all students."

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Next Step

Statistical Literacy has been adopted by

- Augsburg University
- Capella University for their on-line program

Statistical Literacy is being considered by

- U.S. Coast Guard Academy

We are looking for other schools who want to pilot this integration of QL and critical thinking.

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