

Statistical Literacy for Majors w/o Math Reqs.

MILO SCHIELD

Augsburg College

Director, W. M. Keck Statistical Literacy Project

www.Augsburg.edu/StatLit

www.StatLit.org

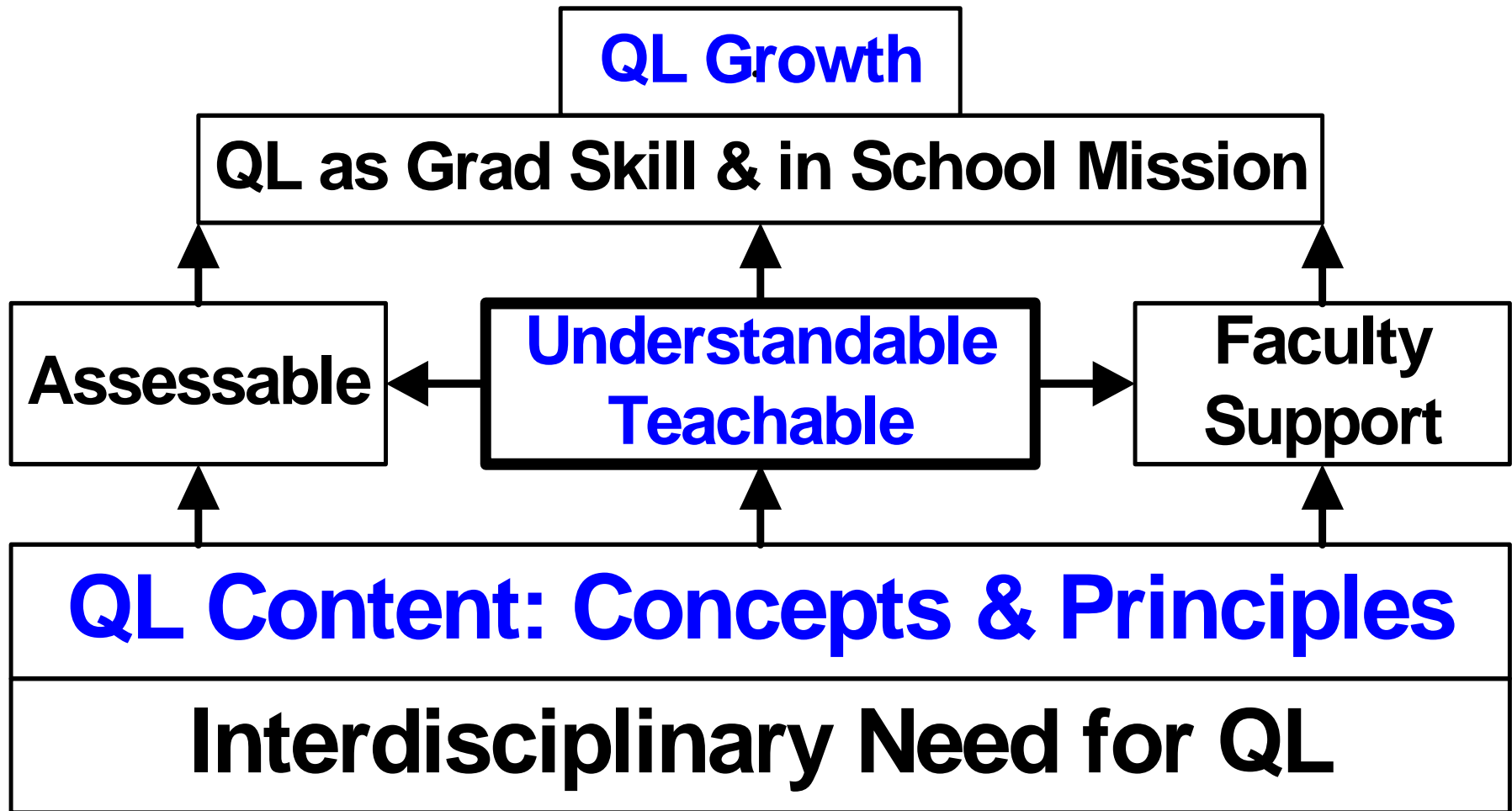
Schild@augsburg.edu

Quantitative Literacy Conference

University of Wisconsin, River Falls Campus

10 March 2006

Content: Keystone to Growth in QL



QL must be Understandable & Teachable

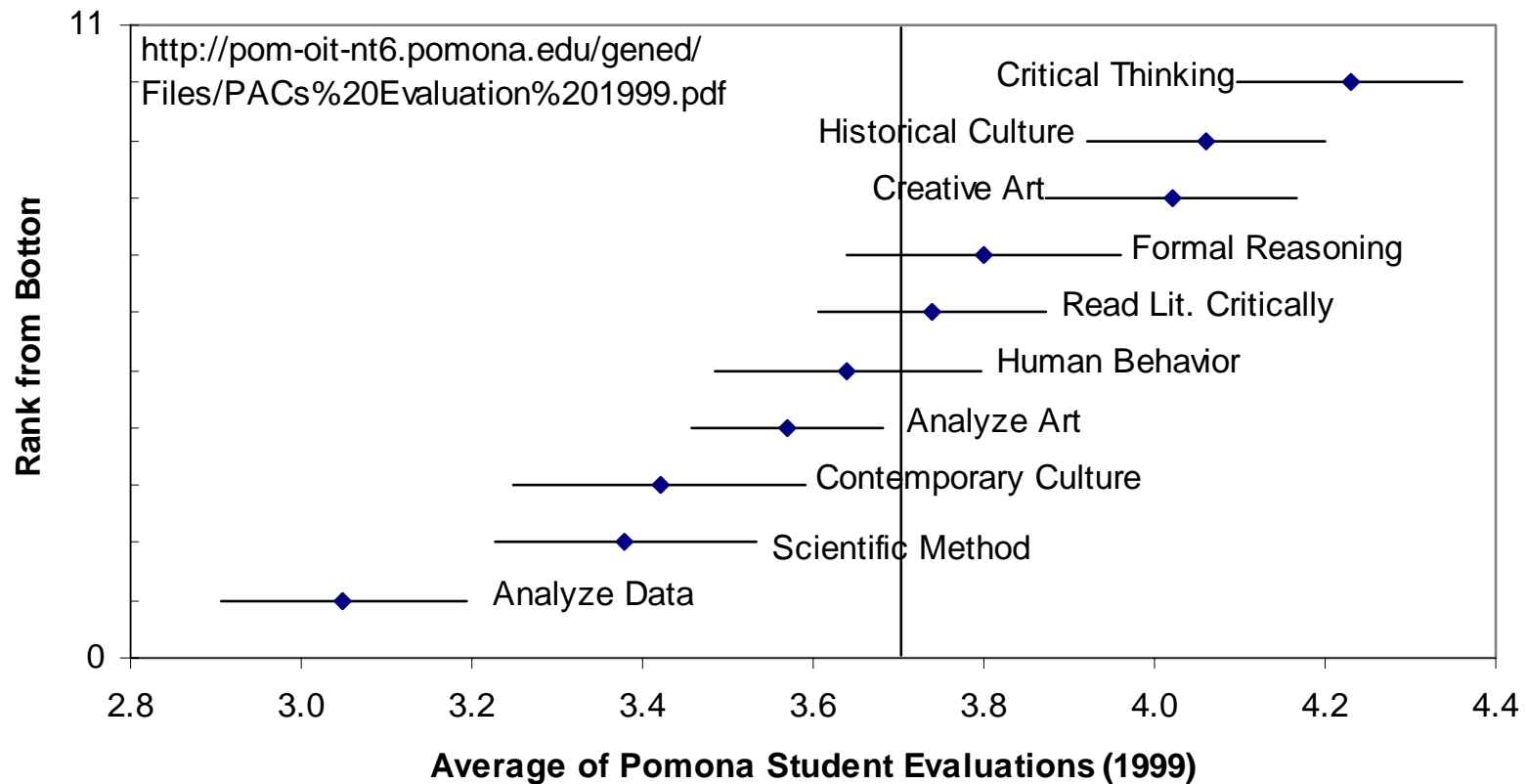
"Because of their education and training, most teachers are not prepared for or comfortable with the mathematics required for quantitative literacy."

"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."

Negative attitudes toward Math/Stats

Value of Pomona Core Competencies
95% Error bars assume SD = 1 on 5 point scale



Business Student's Perception of Statistics

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

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

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).

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)

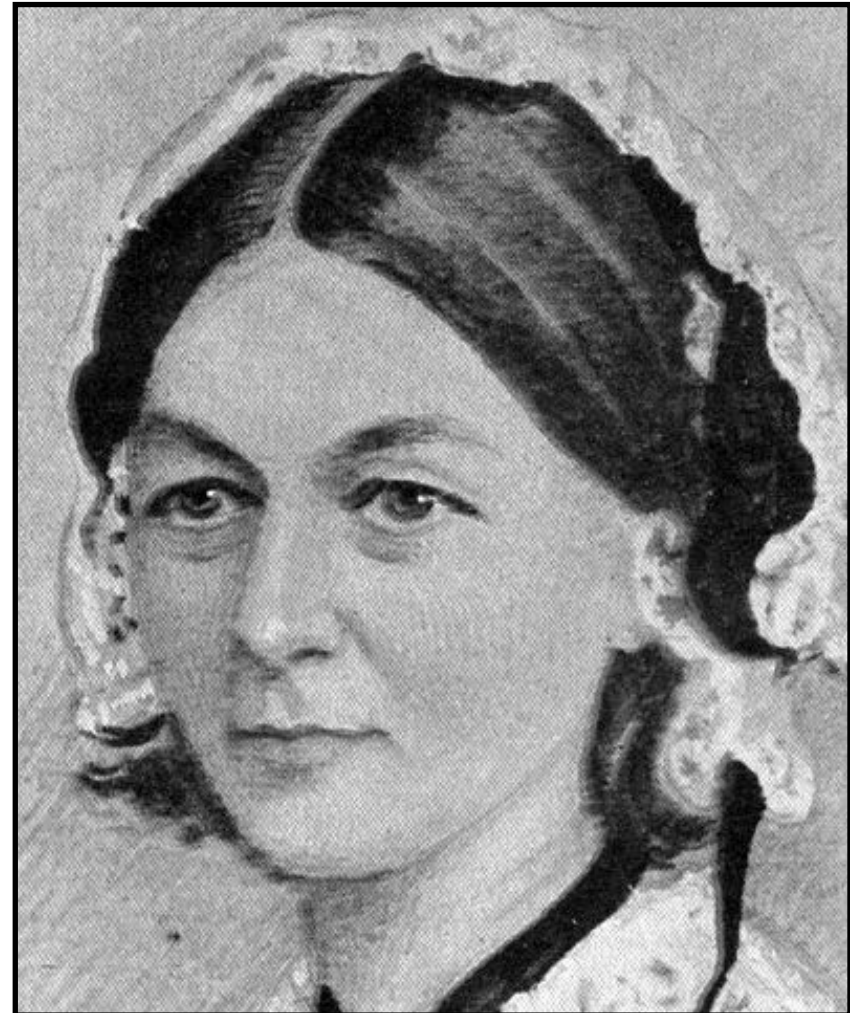
Statistical LITERACY

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!



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.

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)**

#1: Numeric Comparisons Control For Context

Qualitative vs. quantitative

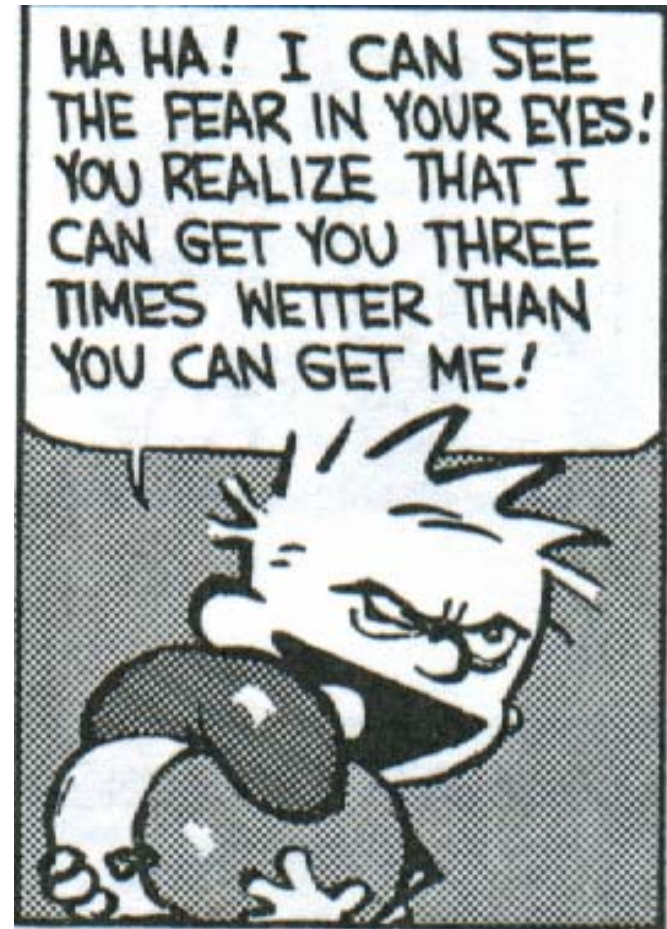
- Napoleon was shorter than many French soldiers
- Napoleon 4" shorter than average French soldier

- 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!**

Simple Arithmetic Comparisons



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

#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

#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

Q/L: Interpreting Medical Tests

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**

FDA
APPROVED
U.S. FOOD & DRUG ADMINISTRATION
Premarket approval # BP950002

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

“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

#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].

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.

#4: Standardizing Ratios Controls For Context

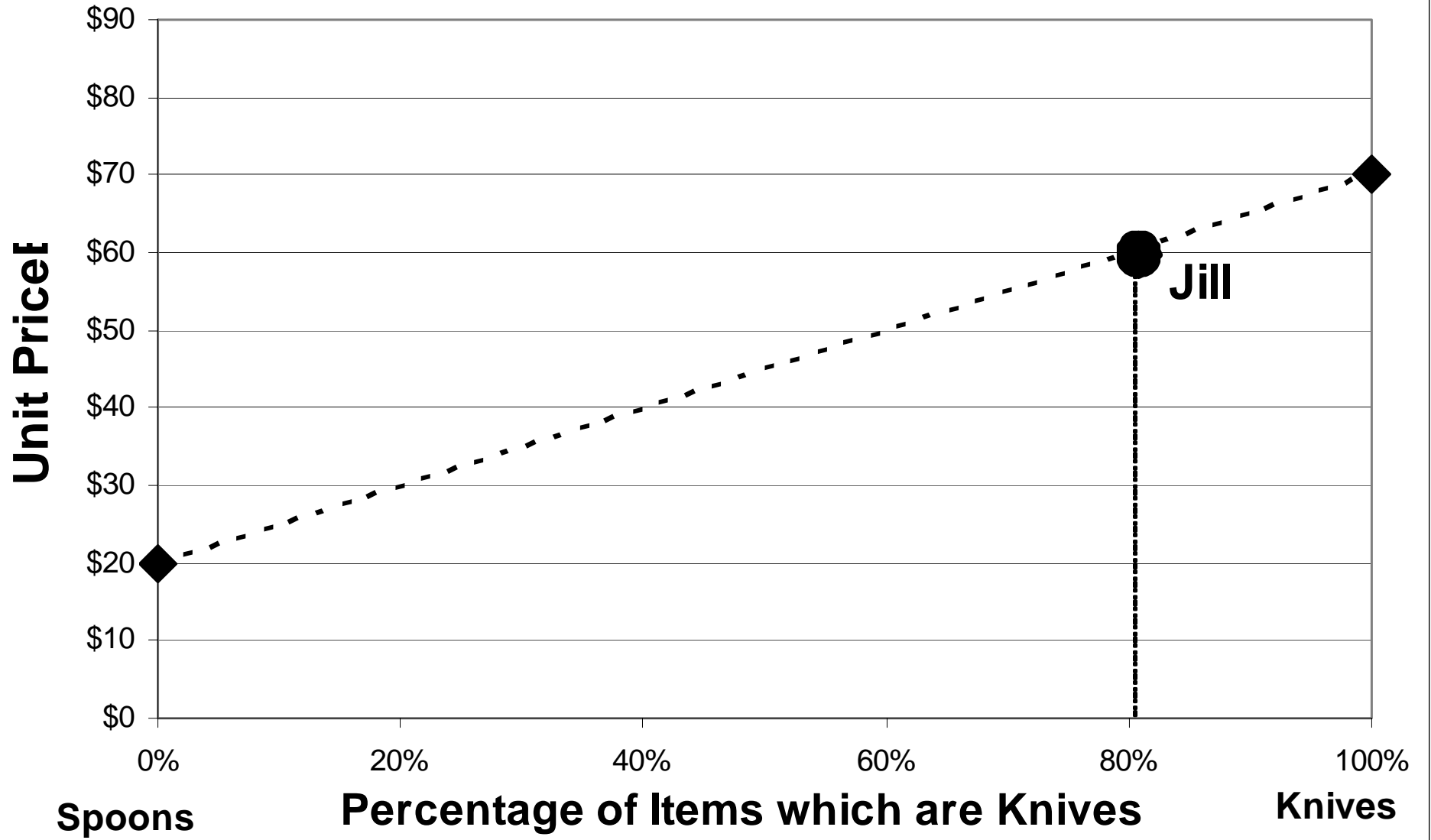
Once you have ratios (percentages, rates or averages) or comparisons of ratios, many students mistakenly think no more can be done.

Standardizing takes into account the influence of confounders on ratios.

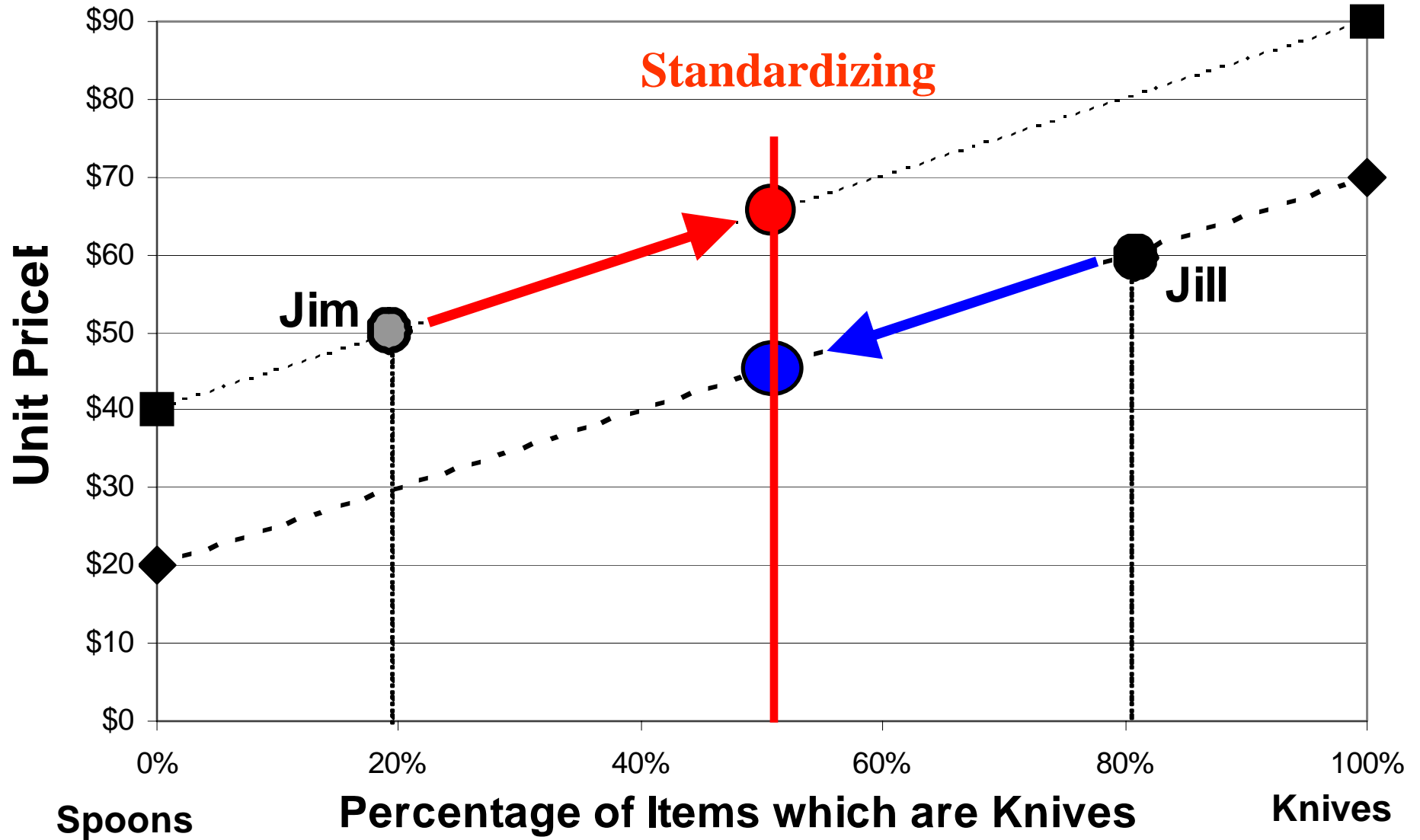
Standardizing links mathematics, confounding and context in ways that everyone should know.

Standardizing involves multivariate thinking.

Weighted-Average Graph: Silverware (Jill)



Weighted-Average Graph: Silverware (Both)



#4: Numbers in Context: Multivariate Thinking

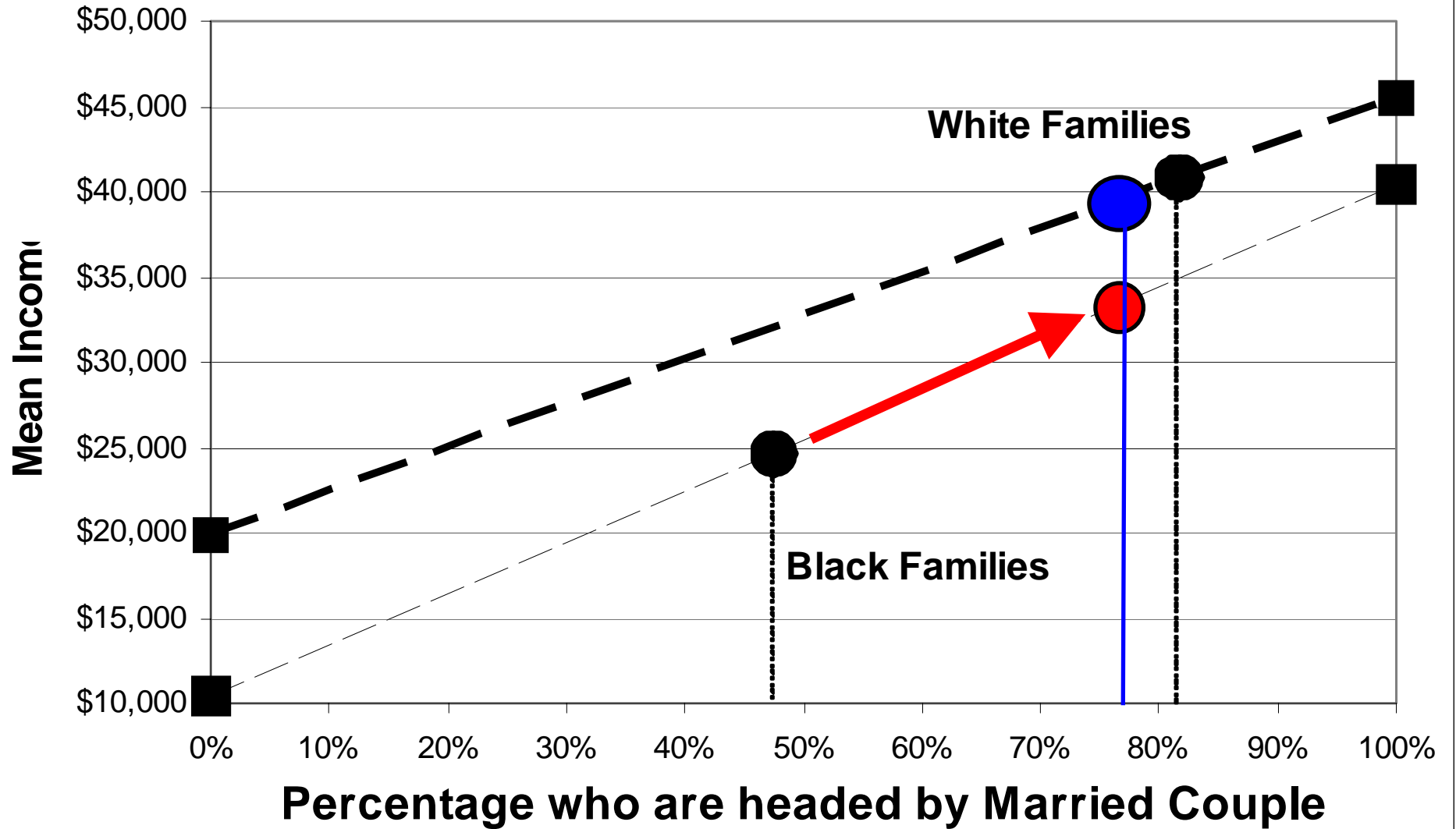
Let's try an example in Public Affairs:

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?

Income: US Families by Race & Structure



#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

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**.

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).

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.

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.”

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.

References

www.Augsburg.edu/StatLit

Schild, Milo (2004b). *Statistical Literacy and Liberal Education at Augsburg College*. AACU Peer Review.

Isaacson, Marc (2005). *Statistical Literacy – An Online Course at Capella University*. 2005 ASA Proceedings of the Section on Statistical Education

Schild, Milo (2005a). *Statistical Prevarication: Telling Half Truths without Lying*. IASE conference Sydney Au.

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

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

Schild, Milo (2004a). *Statistical Literacy Curriculum Design*. IASE Curriculum Design Roundtable, Lund Sweden.