Abstract Type: Roundtables with Lunch Sponsor: Section on Statistical Education

Moderator: Milo Schield, webmaster of www.StatLit.org

Title: Teaching confounding and multivariate thinking in introductory statistics

Abstract: Observational studies are common in business, economics, sociology, health and education. Confounding is a major problem in observational studies. Confounding requires multivariate thinking: thinking on at least three variables. What should students be taught about confounding in an introductory course? Should students be taught methods of taking into account the influence of a confounder that allow them to work problems? Should students be shown that a statistically-significant relationship can be become statistically insignificant (and vice-versa) by a potential confounder? Should this be done if it means less time to teach traditional statistical methods?

Key words: confounding, multivariate thinking, observational studies, introductory statistics

Name: ____

Institution: ____

Department: ____

E-mail address: ____

Teaching or Have Taught:

Yes	No	math for liberal arts.
Yes	No	remedial (developmental) algebra.
Yes	No	an algebra-based quantitative reasoning (concepts) course: (Bennett/Briggs, Aufmann/Lockwood, Burger/Starbird, Abramson/Isom, Sevilla/Sommers, etc.)
Yes	No	undergraduate introductory statistics: algebra-based statistical inference
Yes	No	introductory math stats: calculus-based statistical inference
Yes	No	2nd undergraduate statistics course: regression and modeling
Yes	No	graduate introductory statistics (MBA): algebra-based, statistical inference
Yes	No	statistical reasoning (concepts) course: (Utts: *Seeing Through Statistics*, Moore's *Concepts and Controversies*).
Yes	No	statistical literacy (taken broadly) or quantitative journalism: (Joel Best; *Damned Lies and Statistics*; Vic Cohn: *News and Numbers*, etc.).

Other related courses:

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2008 ASA ROUNDTABLE PARTICIPANT SURVEY [No right-wrong answers]
Circle your answers.

Of all the stories you have read in the news involving the use of statistics as evidence,…

Q1. what percentage explicitly mention influence of chance? [C.f., "statistically significant" difference]
a. < 5% b. 10% c. 25% d. 50% e. 75% f. 90% g. > 95%

Q2. what percentage involve the influence of chance? [C.f., random sample; significant difference]
a. < 5% b. 10% c. 25% d. 50% e. 75% f. 90% g. > 95%

Q3. what percentage involve unmeasured confounders? [E.g., Obesity kills 400K (w/o adjusting for age)]
a. < 5% b. 10% c. 25% d. 50% e. 75% f. 90% g. > 95%

Of all the examples in introductory statistics textbooks that show "association is not causation", …

Q4. what percentage involved the influence of chance? [E.g., Association is not statistically significant.]
a. < 5% b. 10% c. 25% d. 50% e. 75% f. 90% g. > 95%

Q5. what percentage of these examples involved confounders? [C.f., Berkley discrimination]
a. < 5% b. 10% c. 25% d. 50% e. 75% f. 90% g. > 95%

Of all the introductory statistics textbooks you have used or examined, …

Q6. what percentage had a problem or exercise involving the influence of a third factor?
a. < 5% b. 10% c. 25% d. 50% e. 75% f. 90% g. > 95%

Q7. what percentage told the students that a statistically-significant relationship could be made statistically insignificant (or vice versa) after taking into account the influence of a confounder?
a. < 5% b. 10% c. 25% d. 50% e. 75% f. 90% g. > 95%

Agree/disagree:

Q8. Students in introductory statistics should be taught that a confounder can influence the statistical significance of an association – assuming extra time is available for this topic.
a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

Q9. Students in introductory statistics should be taught that a confounder can influence the statistical significance of an association – even if it means there is less time for statistical inference?
a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

Q10. Statistical educators should support teaching about the influence of confounding on observational associations in the introductory statistics course as an integral part of the GAISE guidelines.
a. strongly disagree b. disagree c. neutral d. agree e. strongly agree

Q11. Why don't introductory statistics textbooks include more on confounder influence?
Rank order the following six reasons (1 is most important). No ties please.

___ Takes too much time to teach (diagnostics) ___ Statistics software needed to work problems
___ Takes time from teaching statistical inference ___ Not applicable under random assignment
___ Inference is more important than confounding ___ Reserve 2nd course for confounding

Q12. What are some other reasons than those listed above? [Leave blank if none come to mind.]

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Abstract Type: Roundtables with Lunch Sponsor: Section on Statistical Education

Moderator: Milo Schield, webmaster of www.StatLit.org milo@pro-ns.net
Director of the W. M. Keck Statistical Literacy Project at Augsburg College

Title: Teaching confounding and multivariate thinking in introductory statistics

Abstract: Observational studies are common in business, economics, sociology, health and education. Confounding is a major problem in observational studies. Confounding requires multivariate thinking: thinking on at least three variables. What should students be taught about confounding in an introductory course? Should students be taught methods of taking into account the influence of a confounder that allow them to work problems? Should students be shown that a statistically-significant relationship can be become statistically insignificant (and vice-versa) by a potential confounder? Should this be done if it means less time to teach traditional statistical methods?

Key words: confounding, multivariate thinking, observational studies, introductory statistics

Attendees:

BACKGROUND ON CONFOUNDING:

Moore, D. (1997). Statistical Literacy versus Statistical Competence.[1] ASA JSM.
"Beware the lurking variable"

Utts, J. (May 2003). *What Educated Citizens Should Know About Statistics and Probability?* The American Statistician, Vol. 57, No 2, p. 74-59.

Excerpts: "There are of course many important topics that need to be discussed in an elementary statistics course. For this article, I have selected seven topics that I have found to be commonly misunderstood by citizens, including the journalists who present statistical studies to the public." "1. When it can be concluded that a relationship is one of cause and effect, and when it cannot, including the difference between randomized experiments and observational studies.…

SIMPSON'S PARADOX:

Wainer, H. (2004). "Three Paradoxes in the Interpretation of Group Differences." Draft of a paper submitted to *The American Statistician*.[2]

Schield, M. (1999). Simpson's Paradox and Cornfield's Conditions. 1999 *ASA Proceedings of the Section on Statistical Education*, p. 106-111.[3]

Schield, M. and J. Terwilliger (2004). Frequency of Simspon's Paradox in NAEP Data. AERA Conference.[4]

GRAPHICAL TECHNIQUE FOR STANDARDIZING:

Lesser, L. (2001). "Representations of Reversal: Exploring Simpson's Paradox." In Albert A. Cuoco and Frances R. Curcio (Eds.). *The Roles of Representation in School Mathematics*, pp. 129-145. [chapter in 2001 NCTM yearbook].[5]

Wainer, H. (2002). "The BK-Plot: Making Simpson's Paradox Clear to the Masses." *Chance Magazine* Vol. 15, No. 3, p. 60–62.

Schield, M. (2004). Presenting Confounding and Standardization Graphically. *ASA STATS Magazine*.[6]

STATISTICAL LITERACY COURSE: CONFOUNDER INFLUENCE ON ASSOCIATIONS, EVENTS ATTRIBUTED AND STATISTICAL SIGNIFICANCE

Schield, M. (2004). *Statistical Literacy and Liberal Education at Augsburg College*. 2004 Summer Issue of Peer Review, AACU.[7]

Schield, M. (2004). *Three Graphs to Promote Statistical Literacy*. 2004 ICME, Copenhagen.[8]

Schield, M. (2008). *Confounder Influence on Attributed Cases*. 2008 MAA MathFest, Madison, WI.[9]

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[1] Copy at www.statlit.org/PDF/1997MooreASAslides.pdf
[2] Copy at www.StatLit.org/pdf/2004WainerASA.pdf
[3] Copy at www.StatLit.org/pdf/1999SchieldASA.pdf
[4] Copy at www.StatLit.org/pdf/2004SchieldTerwilligersAERA.pdf
[5] Copy at www.statlit.org/PDF/2001LesserNCTM.pdf
[6] Copy at www.StatLit.org/pdf/2004SchieldSTATS.pdf
[7] Copy at www.StatLit.org/pdf/2004SchieldAACU.pdf
[8] Copy at www.StatLit.org/pdf/2004SchieldICME.pdf
[9] Copy at www.StatLit.org/pdf/2008SchieldMathFest6up.pdf

TITLES AND ABSTRACT:
Simpson's Paradox occurs for two states when their difference in scores has the opposite sign of the score differences for each of the state subgroups. Simpson's Paradox is a specific manifestation of statistical confounding. The paradox has been understood for many years but is usually regarded as simply a curious anomaly. The purpose of this paper is to show that Simpson's Paradox is not rare in NAEP data. NAEP public-school data are analyzed for 2000n Grade 4 Math and 2002 Grade 8 Reading. Conditions for a Simpson's reversal are presented. Approximately 100 instances of Simpson's Paradox are found per data set based on the influence of three confounders: family income, school location and race/ethnicity. In analyzing the influence of race/ethnicity two approaches are used. A straight forward approach generated 64 Simpson's reversals in the NAEP 2002 Grade 8 reading data of which 18 involve initial differences that are statistically significant. A more liberal approach generated 117 Simpson's reversals in the same data set of which 52 involve initial differences that are statistically significant. Either way these results support the claim that Simpson's Paradox is not rare in NAEP data. **As a percentage of all pairs of state differences in the same data that are statistically significant, 4% are reversed using a conservative approach while 10% are reversed using a more liberal approach. All Simpson's reversals – whether statistically significant or not – are argued to have 'journalistic significance' because of their political significance.** Recommendations include ordering the data by key confounders as an adjunct when reporting results. The failure to allow adjustments for confounders can lead to a serious misinterpretation of the results which in turn can lead to questionable policies.