Published in **PEER REVIEW**, Quantitative Literacy issue (Summer 2004)
www.aacu-edu.org/peerreview/index.cfm

Statistical Literacy and Liberal Education at Augsburg College

Milo Schield, professor of business administration,
Director, W. M. Keck Statistical Literacy Project, Augsburg College

Statistical literacy is critical thinking about arguments that use statistics as evidence. Statistical literacy focuses primarily on inductive reasoning and strength of argument for a disputable claim. In observational studies, statistics are contextual; they depend on what is taken into account. This focus on context is why statistical literacy can be viewed as an essential component of a liberal education. And given the role of observationally-based statistics in modern life (e.g., public policy issues, school quality, health choices), statistical literacy should be an essential component of education for responsible citizenship and effective personal decision making.

According to the AACU Presidents' Campaign, the aims of a liberal education include "developing intellectual and ethical judgment, and expanding cultural, societal and scientific horizons." If this education is to be a 21st century liberal education, then students must be statistically literate.

Statistical literacy includes many elements of quantitative literacy. It involves the mathematical approach in focusing more on signal and pattern than on noise or chance; it involves the statistical approach in focusing on the role of context, conditional reasoning and variation. But statistical literacy goes beyond quantitative literacy or numeracy by focusing on the ability to read, to interpret and to communicate. Numeracy focuses primarily on numbers; statistical literacy focuses more on the words framing the numbers.

The primary goal of the W. M. Keck Statistical Literacy Project is to develop statistical literacy as an interdisciplinary curriculum in the liberal arts. William Frame, president of the College, observed, "Augsburg has a long history of uniting the liberal and the practical to prepare students as citizens and stewards of the world. This concept [statistical literacy] is central to our effort in behalf of interdisciplinarity." And indeed, statistical literacy is a key component of a practical liberal arts education. As Augsburg's director of general education, Professor Joan Griffin, has noted, "statistical literacy, with its strong focus on arguments involving statistics in public policy, helps students become better citizens and leaders."

Numbers and Words

In the statistical literacy course at Augsburg College, students learn to distinguish the truth of the statistic from the strength it gives in an argument. One example involves two hunters being chased by a bear (Friedman 1997). The first hunter says, "We're doomed. This bear can run faster than we can." The second hunter says, "No! I don't have to outrun the bear; I just have to outrun you." The truth of the statistic (run faster) is independent of its support for the truth of the claim.

By focusing on grammar to distinguish association from causation, students reflect on differences between statements like the following: "People who are heavier tend to be taller," "as weight increases, height tends to increases;" "increasing weight tends to increase height;" and "if people gain weight they can expect to become taller." The first asserts association; the last asserts causation. To social scientists the middle two assert association, but to most readers they assert causation.

Students also focus on the definitions of soft terms such as "bullying." What is it? Can "bullying" be defined to make the percentage of students who are involved in bullying a larger or smaller number?

Students quickly learn that small changes in syntax can produce large changes in semantics. In describing ratios, they learn that "the percentage of women who are runners" is different from "the percentage of women among runners." In comparing ratios, they learn that "widows are more likely among suicides than are widowers" is quite different from "widows are more likely to commit suicide than are widowers." They describe and compare rates and percentages in tables and graphs. These students are studying conditional reasoning using ordinary language instead of algebra.

Moreover, this statistical literacy course teaches students to be aware that statistics can be ambiguous. Compared to Hawaii's rate, for example, the 1996 auto death rate in Arkansas was 104 percent higher (per vehicle), 78 percent higher (per registered driver) and yet 77 percent lower (per mile of road). The term "auto death rate" is ambiguous; it does not say whether the rate is per vehicle, per driver, or per mile of road. Students also study the "confusion of the inverse." They learn that "most accidents occur within 25 miles of home" does not mean "accidents are less likely when driving further from home."

Numbers in Context

Having learned how to use words more precisely, students have the foundation in conditional reasoning needed to see that, in observational studies, statistical associations are contextual: their value depends on what one takes into account.

Students are generally aware that taking into account the size of a group can change the direction of an association involving counts. They know that even if "more people are unemployed in California than in Iowa," it still may be that "the unemployment rate is higher in Iowa than in California." But they lack experience in seeing how ratios such as averages or

percentages can change by taking into account the influence of a confounder. A confounder is any related factor or a lurking variable that is tangled up with an association.

For example, students are often perplexed to learn that the hospital with the highest death rate in a state is often the leading research hospital. This seems to be a basis for action, but students realize this may not mean the research hospital is a bad hospital, i.e. that it has untrained doctors, inept nurses, and inadequate facilities. They quickly realize the high patient death rate may be due to a confounder: the high percentage of patients who are in poor condition. Students realize they must think—or rethink—about context before concluding or acting.

This statistical literacy course helps students learn a new graphical technique for standardizing patient death rates so that two hospitals having different mixes of patient conditions can be compared on the same basis. Using this technique, they can calculate weighted averages graphically and they can readily explain how or why a statistic changed. These students are handling problems in multivariate thinking that are not taught in most introductory statistics courses.

Using this graphical technique and summary data from the U.S. Statistical Abstract, they see that 65 percent of the $16,000 black-white family income gap is explained by the difference in family structure (the percentage of families who are headed by a married couple). Students can also use this graphical technique to see that the 2000 National Assessment for Educational Progress fourth grade math scores for Utah and Oklahoma would reverse after taking into account the influence of family income (based on the federal criteria for lunch subsidies). Students learn that a reversal of an association (Simpson's Paradox) reflects the influence of a confounder in observational data.

Throughout this course students critically reflect on everyday claims in the news that use statistics as evidence: "People who drink green tea weigh less;" "kids who eat a good breakfast do better in school;" "kids who skip class do worse;" etc. Students look for confounders that could provide alternate explanations for these observed associations. Since this critical thinking focus helps them make sense of things encountered in daily life, students find this part of the course especially challenging and rewarding.

Statistical Literacy and Liberal Education

As the Association of American Colleges and Universities points out in its "Statement on Liberal Learning," a liberal education involves "the capacity to understand ideas and issues in context." Thus, statistical literacy, critical thinking about statistics as evidence, is an integral component of a liberal education since a key goal of statistical literacy is helping students understand that statistical associations in observational studies are contextual: their numeric value and meaning depends on what is taken into account. The need to deal with context and confounding is ubiquitous to all observational studies whether in business, the physical sciences (e.g., astrophysics), the social sciences, or the humanities.

Is statistical literacy important? The students think so! On the first day of class, most students say they would not take the course unless it satisfied a graduation requirement. On the

last day of class, students were asked if this course should be required for all students. On a five-level scale, 20 percent said, "absolutely" while another 30 percent "strongly agreed." This is a big change.

Should statistical literacy be taught across the curriculum rather than being a single course within a department? This would seem ideal provided it were sustained and done well. But as Joel Best (2004) noted, "the lack of a departmental owner meant that teaching critical thinking remained everyone's responsibility—and therefore no one's." He concluded that without a disciplinary home, general skills courses such as critical thinking and statistical literacy may not survive since "statistical literacy falls between the stools on which academic departments perch." This is a serious and seemingly intractable problem for these interdisciplinary service courses.

Departments tend to teach service courses as the first course for majors rather than as the last course for non-majors. Disciplines may support the idea of broadening a service course only if they don't give up anything from their discipline in the process. For example, a group of international statistical educators studied statistical literacy in depth. When they were asked if the introductory statistics course should focus more on the role of context and confounding in observational studies they were generally supportive. But when asked if this should be done even if it meant reducing course content involving statistical inference, this same group was seriously divided.

It appears that a much larger effort will be required to locate and nurture a suitable home for those general methods courses that develop the core capacities of a 21st century liberal education.

References

AACU (2002). *Presidents' Campaign for the Advancement of Liberal Learning*. **www.aacu.org/CALL/CALLtext.cfm**

Best, Joel. 2004. *More damned lies and statistics: How Statistics Confuse Public Issues*. Berkeley: University of California Press.

Friedman, David D. 1997. *Hidden order: The economics of everyday life*. New York: Harper Collins.

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Statistical Literacy on the Web

www.StatLit.org is a key site for articles, books and links on statistical literacy.

www.Augsburg.edu/StatLit is home for the W. M. Keck Statistical Literacy Project at Augsburg College.