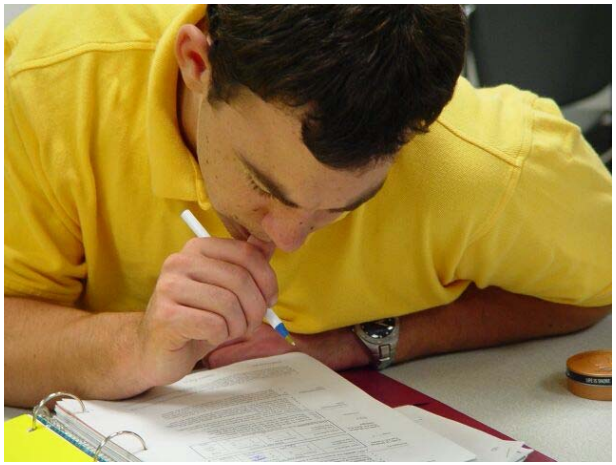
# Statistical Literacy©

critical thinking about statistics as evidence in arguments



# PROJECT OVERVIEW

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# Statistical Literacy
## at Augsburg

Augsburg College offers two courses in Statistical Literacy. Both courses have a common basis: critical thinking about using statistical associations in observational studies as evidence for causal connections. Both courses focus on taking into account *related factors* by using and comparing rates and percentages. The two courses differ in their audience and in some topics.

### GST 200: Quantitative Reasoning (Statistical Literacy)

For majors in the humanities and communications. The focus is on reading and interpreting statistics in graphs and stories. Students have studied "More Guns; Less Crime" and "Damned Lies and Statistics." Used as a pre-stats bridging elective by some students majoring in disciplines that require a traditional chance-based statistics course.

### BUS 379: Quantitative Methods

For majors in Business and Economics. The focus is on confounding in modeling (multivariate regression, logistic regression and classification analysis) and on chance in sampling (confidence intervals and statistical significance).

# Statistical Literacy
## Project Goal

"To generate teaching materials that are usable by faculty and useful to students."

I. Develop teaching materials

Chapters

1. Causality and Association
2. Statistical Studies, Constructs & Bias
3. Describe/Compare Rates & Percentages
4. Ratio Comparisons and Confounding
5. Measurements and Confounding
6. Graphs and Confounding
7. Linear Regression Models: Single Factor
8 Linear Regression Models: Multifactor
9. Other Models: Classification Analysis and Logistic Regression
10 Influence of Chance: Confidence Intervals and Statistical Significance

II. Critique and test teaching materials from a quantitative perspective.

III. Critique and test teaching materials from a critical thinking perspective.

# Statistical Literacy:
## The Evidence

The strength of statistics as evidence in arguments depends on the influence of **chance** (randomness), of **bias** (systematic error) and of **confounding** (relevant factors not taken into account).

- The strength of statistics based on *small-sized, well-designed* ***experiments*** (treatments with random assignment) is most likely to be influenced by *chance*.
- The strength of statistics based on *poorly-designed studies* is most likely to be influenced by *bias*.
- The strength of statistics based on *large-scale, well-designed* ***observational studies*** *(non-experiments)* is most likely to be influenced by *confounding*.

*Observational studies* are much more common than *experiments* in business, in social policy issues, and in the popular press. *Large-scale, well-designed studies* are becoming increasing common. In data mining, the data may be an entire population for a given time period.

## Conclusion

To be statistically literate about statistics as evidence in everyday arguments, students must be aware of *confounding, bias, and chance* ***in that order of importance.***

# Statistical Literacy:
## Seeing Confounding

Statistical Literacy focuses on "*seeing the story behind the numbers*": thinking about what factors may be ***confounding*** (confusing) the numbers. This means treating associations as contextual.

- Count Compare: A judicial system may be biased against non-whites even though there are more whites than non-whites in prison (there may be more whites).
- Ratio Compare: A judicial system may be fair even if non-whites are more likely to be in prison for drugs than whites (non-whites may be more likely to consider selling drugs a non-crime than whites).
- Ratio Compare: The hospital with the highest rate of deaths may be the best (more patients may be in poor condition).
- Linear Model: For each additional bedroom, the price of houses increases by $39,000 (p=0.00). After taking into account land values, square footage and number of baths, the price of houses increases by $5,000 per bedroom (p=0.10).

## Moral

Including an additional confounder can change the direction or the amount of an arithmetic association in **any** observational study. Since these associations are contextual, one must always check their context!

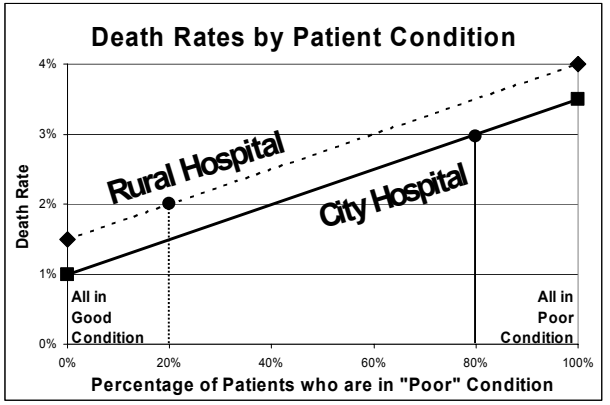
# Statistical Literacy:
## Controlling Confounding

Statistical Literacy focuses on quantitative techniques (ratios, comparisons and **standardization**) to take into account – to control for – the influence of *confounding.*

Using ratios and comparisons includes:

- Describing rates and percentages
- Decoding tables of rates & percentages
- Comparing rates and percentages

*Standardization example*: The death rate in a city hospital was *higher* than a rural hospital (3% vs. 2%). But for patients in good condition, the death rate in the city hospital was *lower* than in the rural hospital (1% vs. 1.5%). The same was true for patients in poor condition (3.5% vs. 4.0%). *So, the standardized death rate* in the city hospital was actually *lower* than the rural hospital.




*Standardization* techniques include standardized scores, standard age populations, multivariate regression and analysis of covariance.