Using learning gains to evaluate instruction in small classes

Brent W. Barker, Kayla Fouch

Dept. of Biological, Chemical, and Physical Sciences
Roosevelt University, Chicago, IL, USA

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The setting

- Introductory college physics with non-calc / calc merged
- 1 FT physics faculty (me!)
- Class size ~40 (pre/post matched size ~25)
- Fluctuations in background/ability affect measured normalized learning gains in conceptual inventories
- How to use normalized gain to measure effect of interventions / course changes between years at same school?

  → that is, how to account for fluctuating background?

(These are plans for research to do this fall. I welcome your feedback.)

Which backgrounds/measures correlate with conceptual inventory normalized gain?

- pretest score - literature is conflicted (Hake 2002, Meltzer 2002, Colleta 2005)
- GPA (Hsieh 2008)
- SAT (Coletta 2007)
- Preinstruction math skill (Meltzer 2002, Hake 2002, Buick 2007)
- Previous subject experience (low, Hake 2002)
- Representational consistency (Nieminen 2012)
- Scientific reasoning (Colleta 2005, Nieminen 2012)
- Spatial reasoning (Hake 2002)
- Student interest (Hsieh 2008)
- Gender (Hake 2002)

→ Want data that are strongly correlated, easy to collect, and avoid cross-correlations (make “orthogonal basis” of correlators)

How to apply adjustment (one idea)

- Use best-fit line to get correlation
- For each student, adjust gain by best-fit line

e.g. find $y = mx + b$ best fit line for a certain (variable, gain) set. For each student's individual gain, apply

$$(\text{gain})_i^{\text{adjusted}} = (\text{gain})_i - m(\text{variable})_i$$

$\rightarrow$ no more correlation!

Steps

1. Determine how much different backgrounds are correlated with learning gains
2. Create orthogonal basis of correlators
3. Apply adjustment to nullify effect of correlations
4. Learn how this affects cross-year comparison

Going forward

- We aim to account for fluctuating backgrounds over time by adjusting for those that correlate with learning gains.
- Are the correlations stable over time for our school?
  - Does that matter?
- How strong is the effect of adjustment?
- Is there a better way to account for correlation?
- Are there other adjustments for small-N samples that we should do?
- Is there some Other Glaring Thing that makes this approach ineffective?