Field studies and randomized designs

The example of epidemiology and honors workshops

Epidemiology

- "the branch of medicine that deals with the incidence, distribution, and possible control of diseases and other factors relating to health"
- Typical study is correlational: Higher levels of variable X are associated with more of disease Y
- Adapted from Gary Taubes: "Do we really know what makes us healthy". New York Times Magazine, September 16, 2007.
- http://www.nytimes.com/2007/09/16/magazine/16epidemiology-t.html?_r=2&ref=magazine&pagewanted=all&oref=slogin&oref=slogin

Hormone Replacement Therapy

- Nurses study (observational)
  - HRT is good
- Women's Health Initiative (random assignment)
  - HRT is slightly bad

Nurses Health Study

- Observational study of nurses
- Positive effect of estrogen on heart disease
- but also observed reduction in death by homicide, suicide, and accidents

The bias of healthy users

- “People who faithfully engage in activities that are good for them -- taking a drug as prescribed, ... or eating what they believe is a healthy diet -- are fundamentally different from those who don’t.
- Nurses who took HRT were thinner, fewer risk factors for heart disease, more educated, wealthier, exercise more, more health conscious.

The bias of compliance

- People who comply with their doctors' orders are healthier than those who don't
- Effects are even true for placebo takers!

Doctors' prescribing effect

- People who are eager to take particular drugs are probably different than those who are not

Randomized field trials as an alternative

- Observational studies have all kinds of biases, what about doing random assignment?
- How to do it?
- The example of the Women's Health Initiative

Women's Health Initiative

- Older (pre and post menopausal) women
- Randomized field trial
  - HRT vs placebo
  - Reduced fat versus normal
  - Calcium supplements versus placebo

Participation bias

- Who participates in a random study?
- Who complies with instructions?
- Effect of assignment versus effect of actual treatment

WHI results

- Stopped HRT trials after slightly greater risk of heart attack
- Effect of dietary modification was minimal unless one looked just at the compliant subjects (see above)

The crises in science education

- STEM majors are decreasing
  - Science, Technology, Engineering, Math
- Particularly, women and minorities are not enrolling in or not continuing in STEM courses
- Why is this happening?

Alternative explanations for STEM differences

- Ability
- Interests
- Discrimination
- Stereotype threat

Honors Workshops in STEM courses

- Evidence from calculus classes that study groups help performance
  - Treisman (1992) at UCB found that white and asian males used study groups, females and african-american students did not
  - interpreted differences in test performance as motivational effect

Study group effect on motivation

- Student by him/her self
  - I don’t know how to do problem 6
  - I must be stupid
- Student in study group
  - I know how to do problem 5, you know how to do problem 6, lets teach each other
  - I am not stupid, the material is hard!

Biology Honors workshops at NU

- Students asked if interested in participating
  - volunteers more interested in biology
  - volunteers more anxious
- Among those willing to participate, random assignment to honors study groups or not
- Workshop students did better, more likely to complete the course than those who volunteered but did not participate

- Born, W. K., Revelle, W., & Pinto, L. (2002) Improving Biology Performance with Workshop Groups. *Journal of Science Education and Technology*. 11, 347-365.

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This 2-year quasi-experiment evaluated the effect of peer-led workshop groups on performance of minority and majority undergraduate biology students. The workshop intervention used was modeled after a program pioneered by Treisman (1992). Majority volunteers randomly assigned to workshops ($n = 61$) performed significantly better than those assigned to the control group ($n = 60$, $p < 0.05$) without spending more time studying. Workshop minority students ($n = 25$) showed a pattern of increasing exam performance in comparison to historic control minority students ($n = 21$), who showed a decreasing pattern ($p < 0.05$). Volunteers ($n = 121$) initially reported that biology was more interesting and more important to their futures than did nonvolunteers' ($n = 435$, $p < 0.05$). Volunteers also reported higher levels of anxiety related to class performance ($p < 0.05$). The relationship of anxiety to performance was moderated by volunteer status. Performance of volunteers was negatively associated with self-reported anxiety ($r = -0.41$, $p < 0.01$). Performance of nonvolunteers was unrelated to self-reported anxiety ($r = -0.02$). Results suggest elevated anxiety related to class performance may increase willingness to participate in activities such as workshop interventions. In addition, students who volunteer for interventions such as workshops may be at increased risk of performance decrements associated with anxiety. Even so, workshop programs appear to be an effective way to promote excellence among both majority and minority students who volunteer to participate, despite the increased risk of underperformance associated with higher levels of anxiety.

Survey measures

Table II. Survey Measures of Motivation for Nonvolunteer, Control, Workshop Majority, and Workshop Minority Students

				Volunteers								
	Nonvolunteers (Majority)			Control (majority)			Workshop majority			Workshop minority		
Ability	*M*	SD	*n*	*M*	SD	*n*	*M*	SD	*n*	*M*	SD	*n*
Survey 1												
Anxiety[a]	0.00	1.00	131	0.46	0.93	17	0.27	0.96	35	0.60	0.97	14
Interest[a]	0.00	1.00	135	0.33	0.79	16	0.53	1.10	35	0.28	0.85	14
Importance[b]	0.00	1.00	133	0.13	0.57	16	0.40	0.58	36	0.42	0.53	14
Liking	0.00	1.00	133	−0.24	1.07	16	0.00	1.15	36	−0.17	1.23	14
Study hours	0.00	1.00	133	0.00	1.37	17	−0.13	0.76	36	0.57	1.67	14
Survey 2												
Interest	−0.32	1.20	106	−0.87	1.37	14	−0.04	1.07	30	−0.32	1.11	13
Importance	−0.05	0.98	106	−0.01	1.24	14	−0.03	1.17	30	0.00	1.01	13
Liking[c]	−0.50	0.97	106	−0.75	1.05	14	−0.18	0.82	30	−0.72	1.21	13
Study hours[d]	−0.72	0.85	106	0.39	2.66	14	−0.29	1.03	30	−0.26	0.85	13

[a] At Survey 1 nonvolunteers differ from volunteers (control + workshop majority); $p < 0.01$.
[b] At Survey 1 nonvolunteers differ from volunteers (control + workshop majority); $p < 0.05$.
[c] From Survey 1 to Survey 2 nonvolunteers show a steeper decline than volunteers (control + workshop majority); $p < 0.05$.
[d] From Survey 1 to Survey 2 nonvolunteers show a steeper decline than volunteers (control + workshop majority); $p < 0.01$.

Change over time

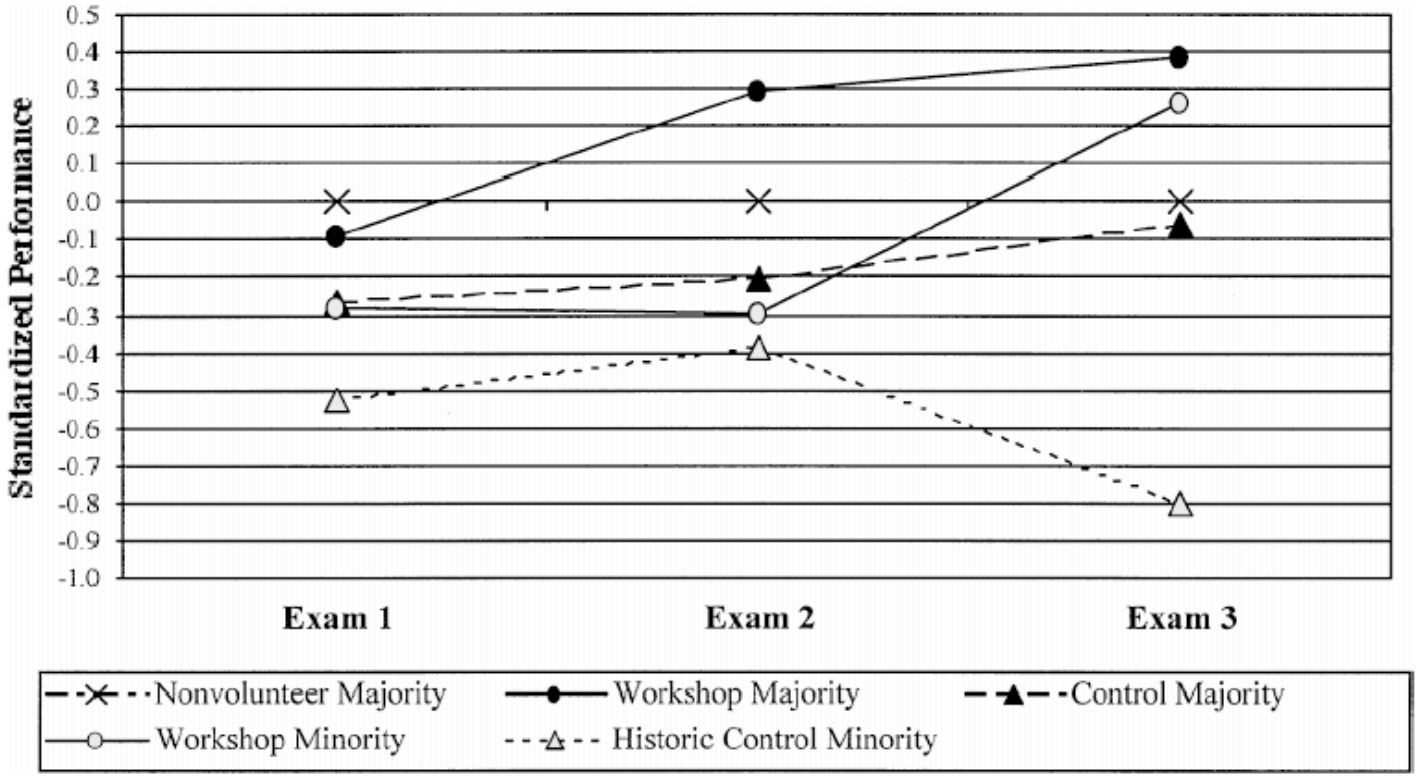


Fig. 1. Standardized Quarter 1 exam performance as a function of group, controlling for prior cumulative grade point average.

Control for grade point

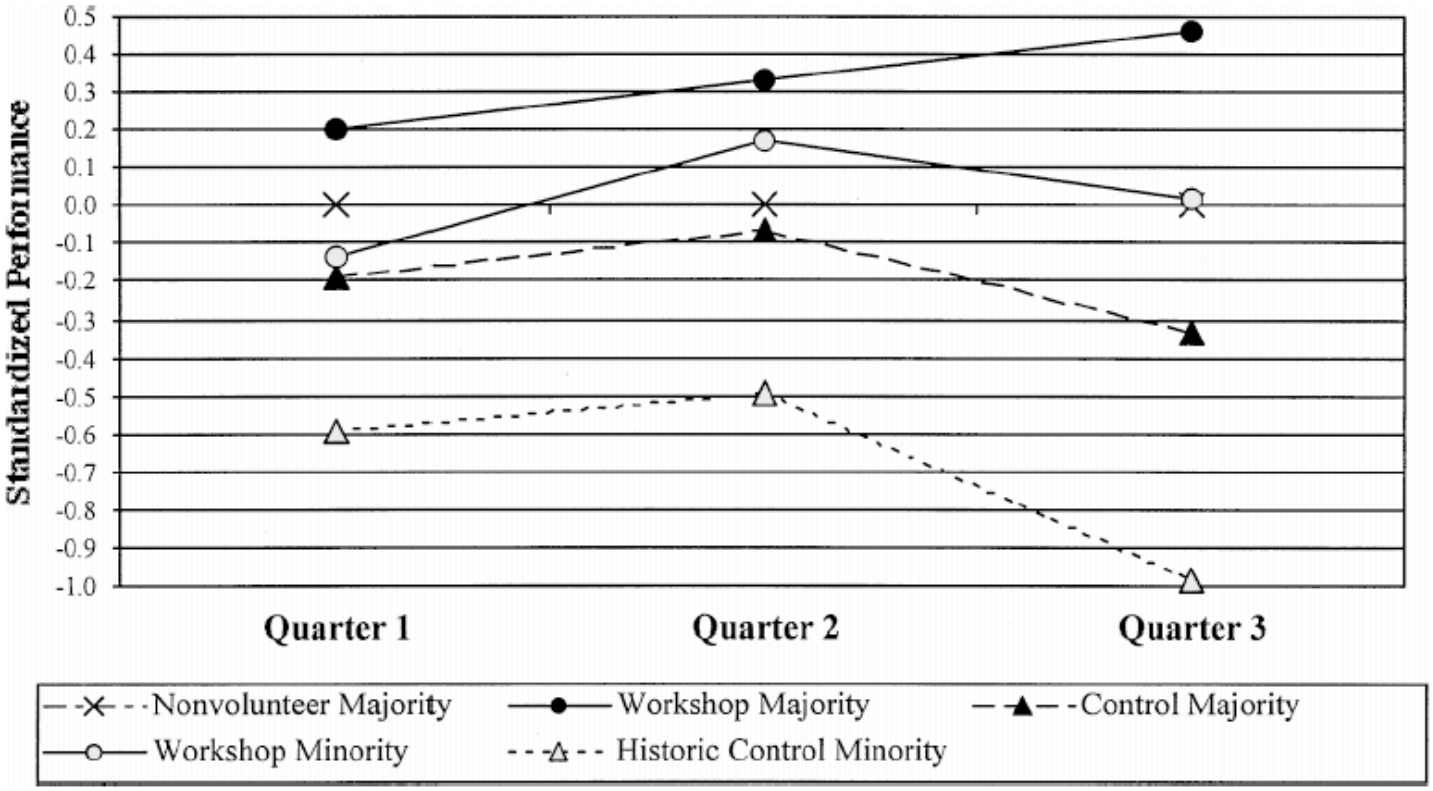


Fig. 2. Standardized performance in each quarter as a function of group, controlling for prior cumulative grade point average.

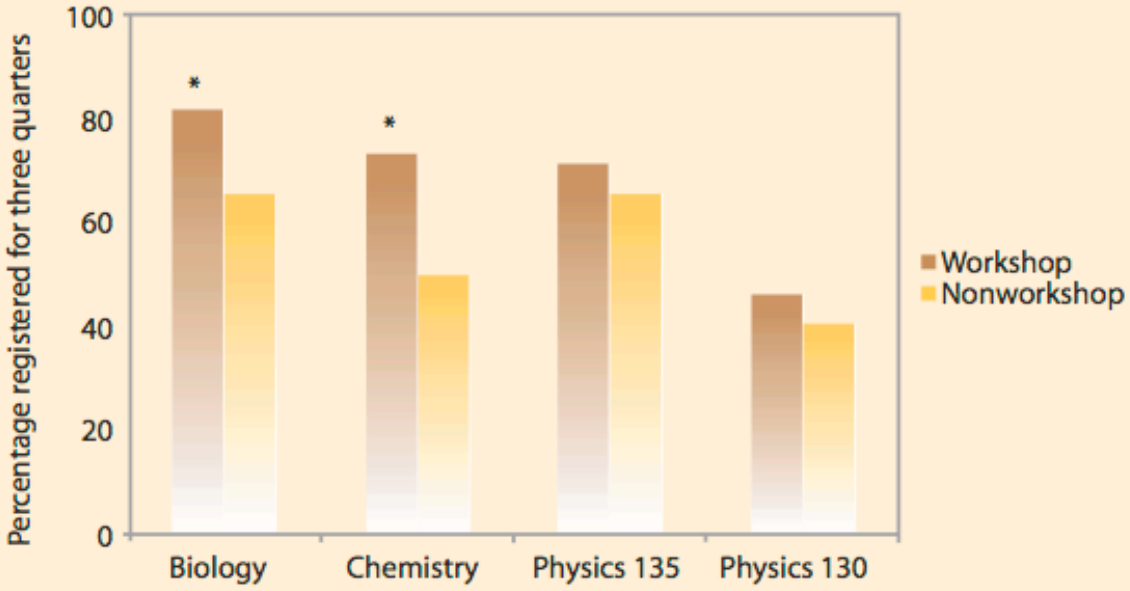
Effect at NU

- All Gateway Science courses now offer honors Gateway Science Workshops

Retention in STEM

FIGURE 2

2001–2002 all student retention over three quarters by workshop participation and discipline.



Retention is defined as the proportion of students who complete all three quarters of the course sequence.

*Significant chi square, $P < 0.05$

Swarat, S., Drane, D., Smith, H.D., Light, G. and Pinto, L. Opening the gateway: Increasing minority student retention in introductory science courses. Journal of College Science Teaching, Vol. 34, No. 1, September 2004.