

FCI Normalized Gains and Population Effects

Populations matter!

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- *Force Concept Inventory (FCI)* – Hestenes et al, 1995 measures understanding of basic Newtonian concepts.
- FCI is administered both pre- and post- instruction to gauge students' progress.

- A useful measure of learning is normalized gain

G :

$$G = \frac{\text{postscore}\% - \text{prescore}\%}{100 - \text{prescore}\%}$$

- Interactive Engagement (IE) classes are more effective than traditional classes in improving conceptual understanding, as measured by FCI – Hake, 1998:

Traditional: G is about **0.2**

IE classes: $G = 0.3 - 0.6$

- Some IE classes have consistently higher gains than others.

WHY?

- Are population effects part of the answer?
- Do students with lower pre-scores have lower gains?
- We analyzed individual and class average data and found positive correlations between G and pre-score.

Individual Students' FCI Data, $N = 2699$

Loyola Marymount University (285)

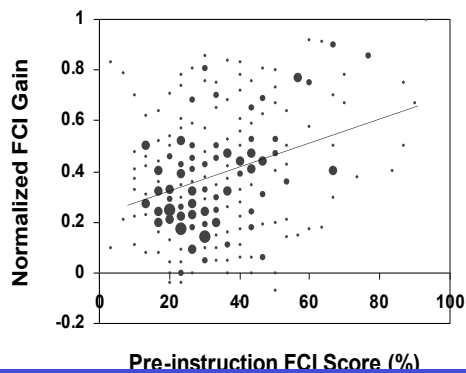
Southeast Louisiana University (96)

University of Minnesota (1648)

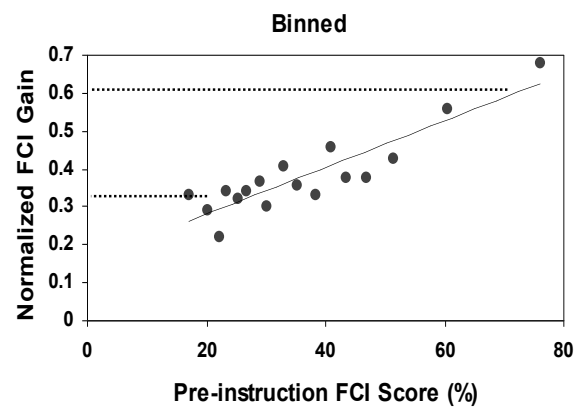
Harvard University (670)

Individual student data

Loyola Marymount University, $N = 285$



$r = 0.33, p < 0.0001$

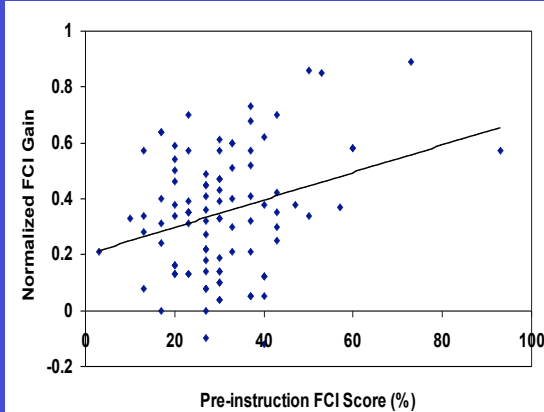


$r = 0.90, p < 0.0001$

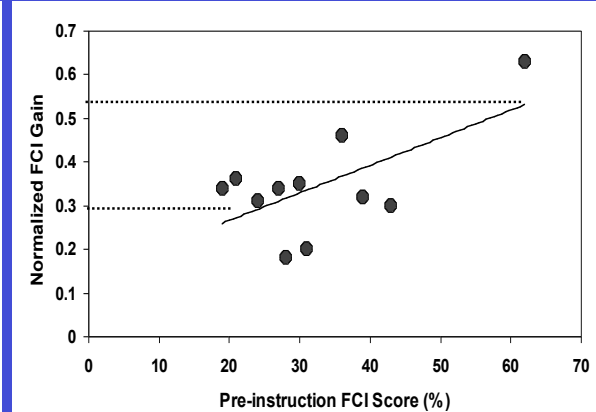
Individual Student Data

Southeastern Louisiana University, $N = 96$

Data courtesy of David Meltzer & Kandiah Manivannan



$$r = 0.30, p = 0.003$$

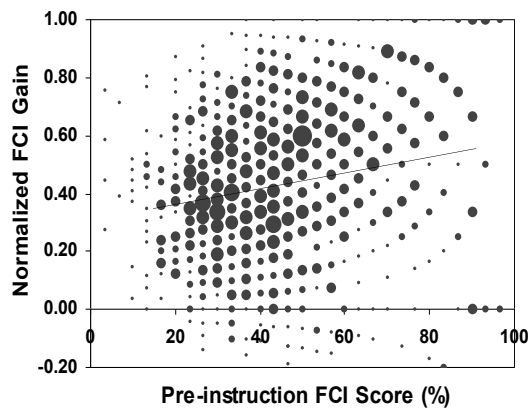


$$r = 0.63, p = 0.04$$

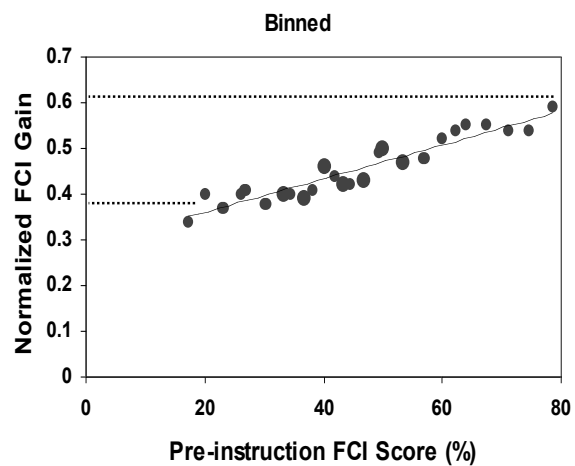
Individual Student Data

University of Minnesota, $N = 1648$

Data courtesy of Charles Henderson & UM PER group,
first presented by Henderson & Heller, AAPT, winter 2000

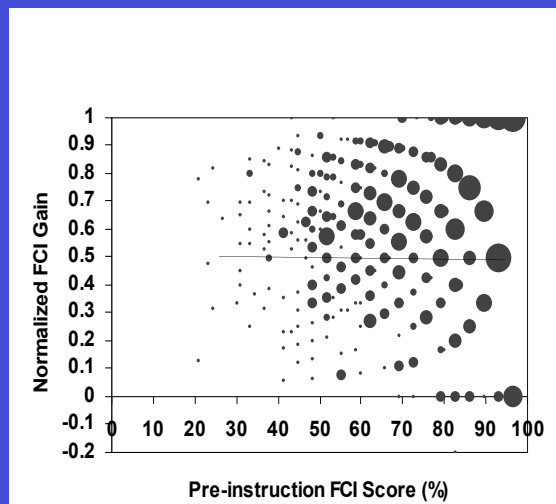


$$r = 0.15, p < 0.0001$$

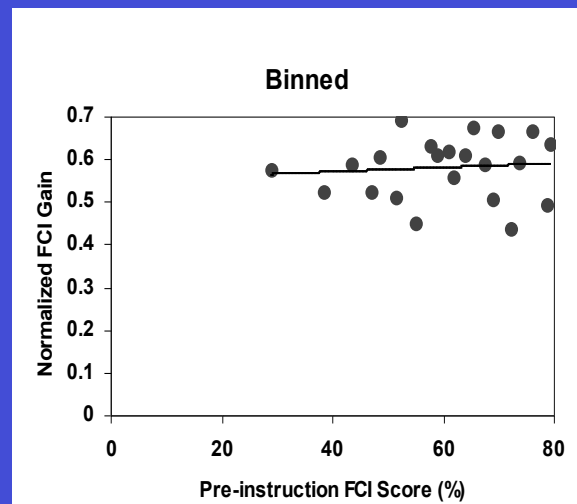


$$r = 0.94, p < 0.0001$$

Individual Student Data
Harvard University, $N = 670$
Data courtesy of Catherine Crouch & Eric Mazur



$$r = 0.037, p = 0.34$$



$$r = 0.04, p = 0.87$$

- Why is there no correlation for the Harvard data?
- Is there another underlying cause of variations in G that is *sometimes* correlated with pre-score?
- Is scientific reasoning ability a cause?

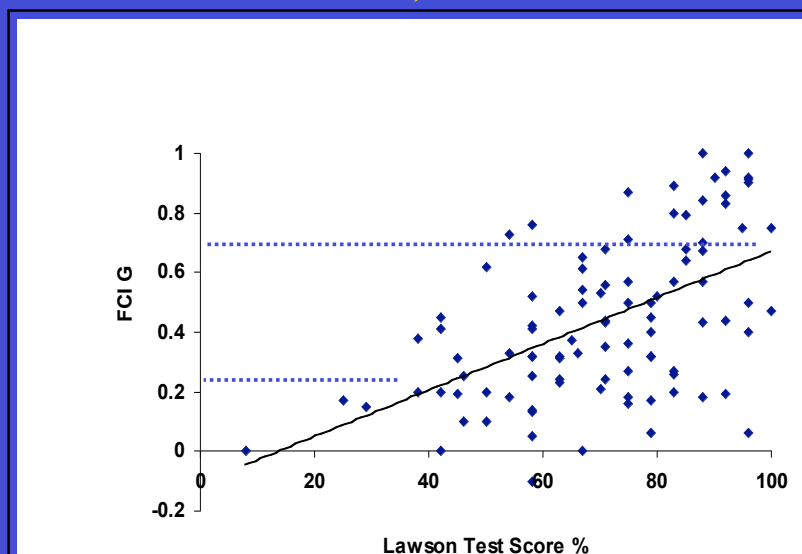
The Lawson Test of Scientific Reasoning Ability

Anton Lawson, Arizona State U.

- reasoning about conservation
- proportional reasoning
- identification of variables
- probabilistic thinking
- hypothetico-deductive reasoning

Individual Student FCI & Lawson Test Data

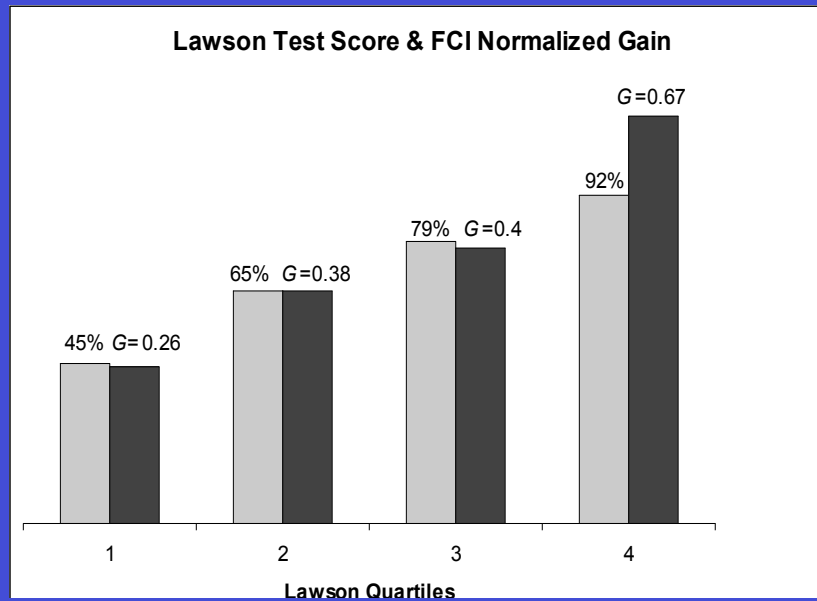
LMU, $N = 98$



$$r = 0.54 \quad p < 0.0001$$

Individual Student FCI & Lawson Test Data

LMU, $N = 98$

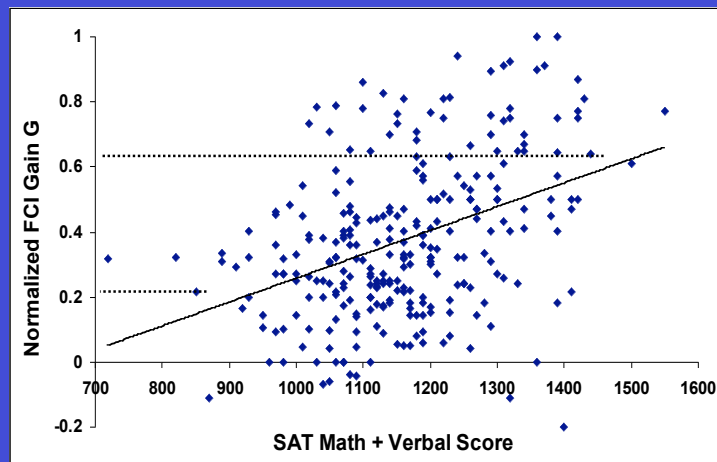


Questions

- Will others observe correlations between Lawson scores & G ?
- When populations are taken into account, are some IE methods significantly more effective than others?
- Do other indicators strongly correlate with FCI G ?
- Can indicators be used to identify students who are at risk & can intervention help them?

FCI G & SAT Math + Verbal Score

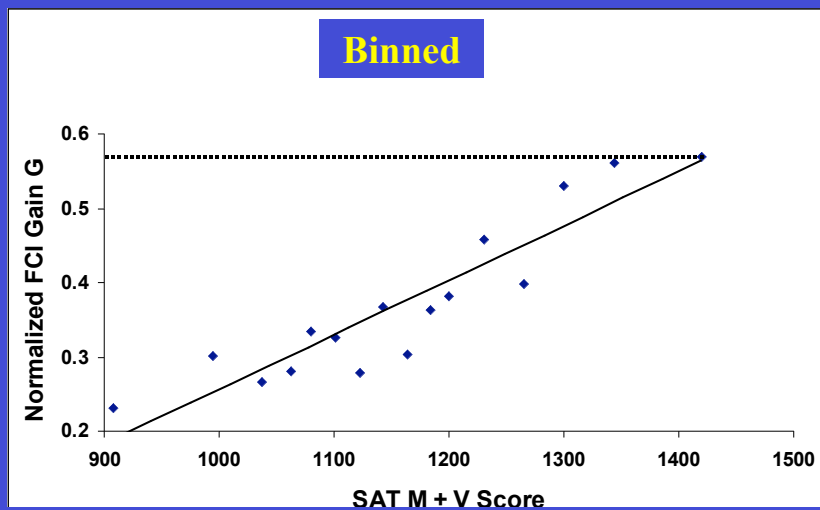
LMU, Fall 1999 to July 2005, $N = 273$



$$r = 0.40 \quad p < 0.0001$$

FCI G & SAT Math + Verbal Score

LMU, Fall 1999 to July 2005, $N = 273$

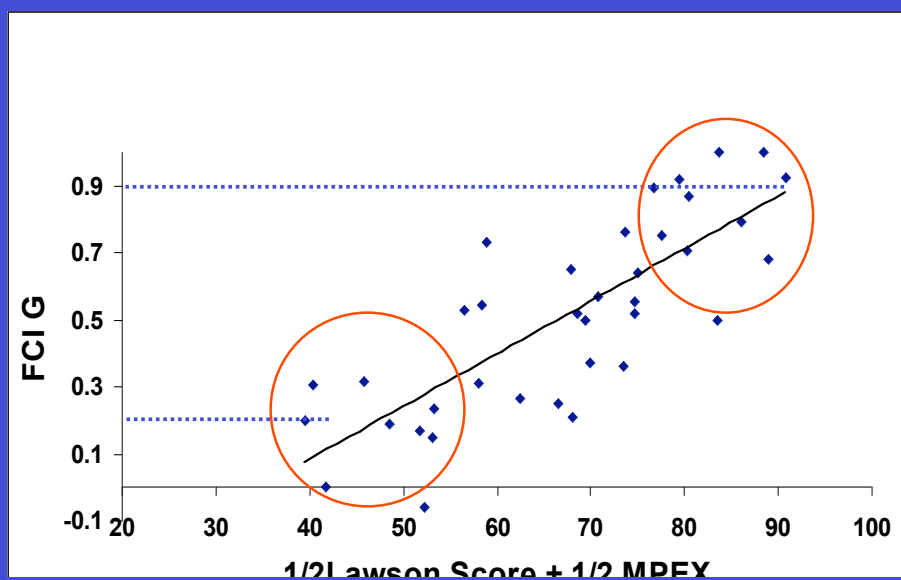


$$r = 0.92 \quad p < 0.0001$$

Attitude as an Indicator

- MPEX is an indicator of attitude toward learning physics.
- In our study ($N = 37$), MPEX scores correlated strongly with FCI G ($r = 0.52$), but were not significantly correlated with Lawson scores.
- Combined MPEX & Lawson scores were very strongly correlated with FCI G .

Lawson & MPEX Combined



$$r = 0.80$$

We need individual student data:

FCI or FMCE

MPEX

Lawson's Test or SAT

Please consider providing data!

Reference: *Interpreting FCI Scores: Normalized Gain, Pre-instruction Scores, & Scientific Reasoning Ability*

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