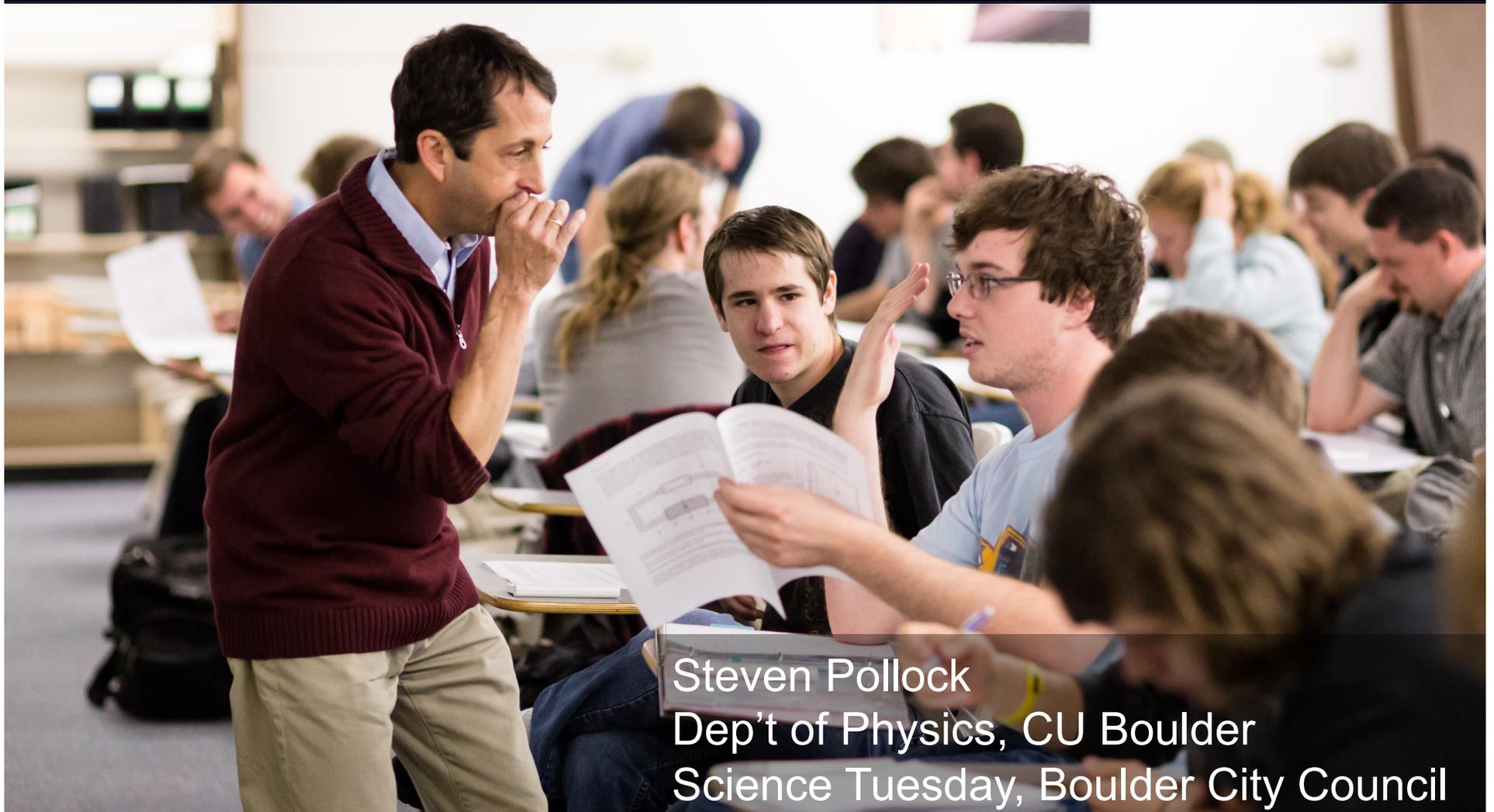


Learning about learning: Physics Education Research in action



Steven Pollock
Dep't of Physics, CU Boulder
Science Tuesday, Boulder City Council

Physics Education Research at CU Boulder

Faculty:

Melissa Dancy
Michael Dubson
Noah Finkelstein
Heather Lewandowski
Valerie Otero
Robert Parson
Kathy Perkins
Steven Pollock
Carl Wieman*

Teachers / Partners / Staff:

Shelly Belleau, John Blanco
Kathy Dessau, Jackie Elser
Molly Giuliano, Kate Kidder
Trish Loeblein, Chris Malley
Susan M. Nicholson-Dykstra
Oliver Nix, Jon Olson
Emily Quinty, Sam Reid
Sara Severance



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Physics Teacher Education Coalition
American Institute of Physics
American Physical Society
National Math & Science Initiative
Howard Hughes Medical Institute

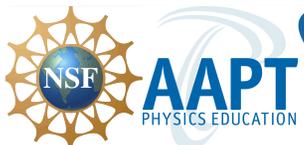
Postdocs/ Scientists:

Stephanie Chasteen
Karina Hensberry
Katie Hinko
Emily Moore*
Ariel Paul
Qing Ryan

Grad Students:

Ian Her Many Horses
George Ortiz
Mike Ross
Ben Spike
Enrique Suarez
Ben Van Dusen
Bethany Wilcox
Rosemary Wulf
+recent grads (4 PhD)

**+ many participating
faculty and LAs**



What is Physics Education Research?



What is Physics Education Research?

Studies *by physicists* of:



What is Physics Education Research?

Studies *by physicists* of:

- How do students learn?



What is Physics Education Research?

Studies *by physicists* of:

- How do students learn?
- How do we know they're learning?



What is Physics Education Research?

Studies *by physicists* of:

- How do students learn?
- How do we know they're learning?
- How do we help them learn?

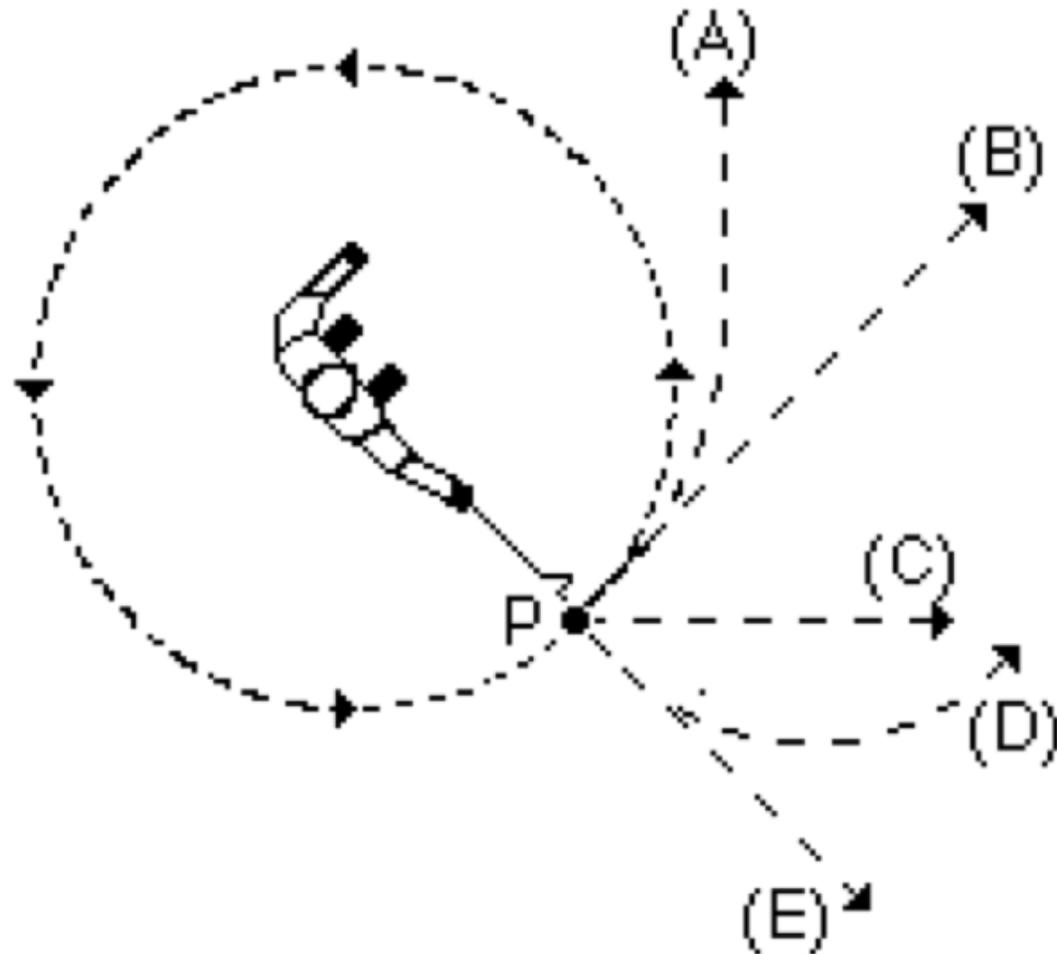


What is Physics Education Research?

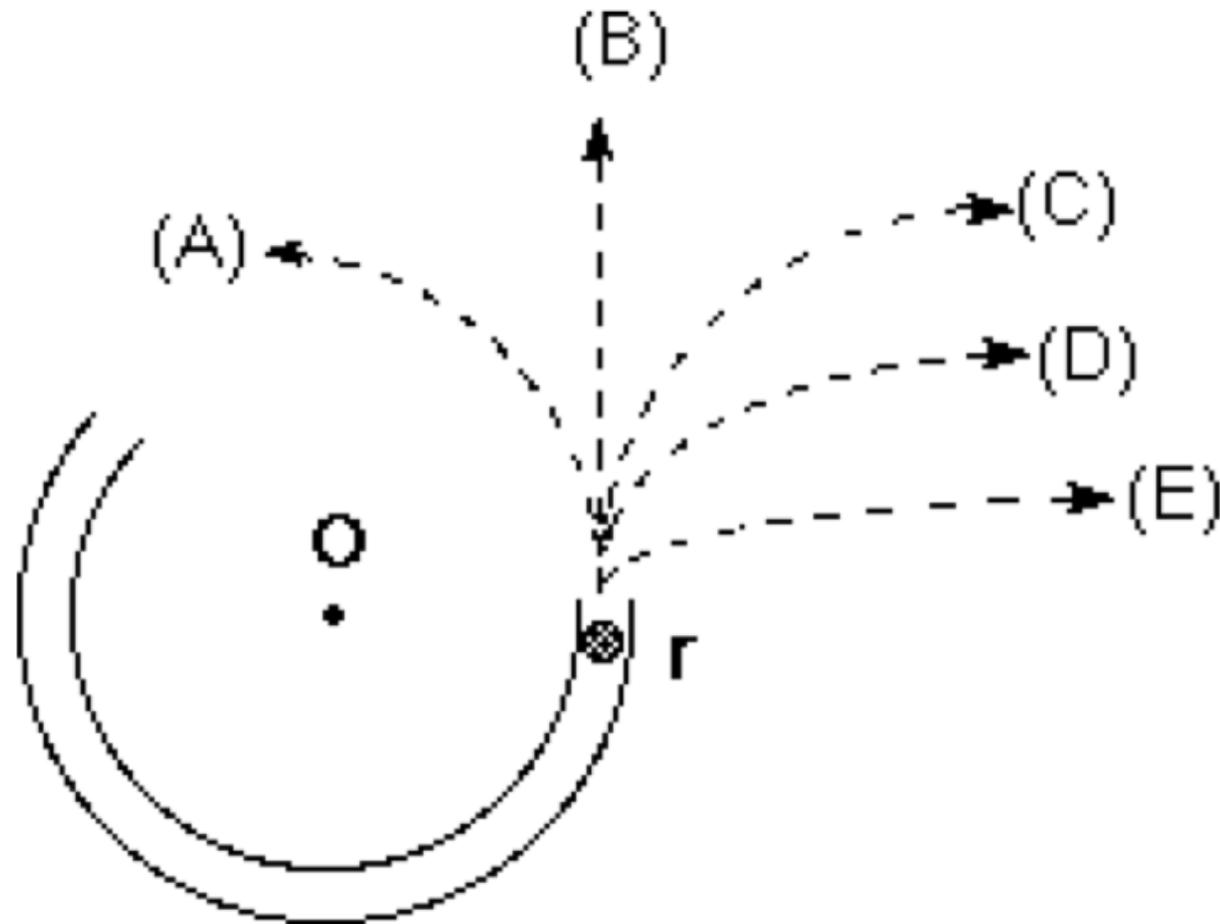
Studies *by physicists* of:

- How do students learn? ← Theory
- How do we know they're learning? ← Experiment
- How do we help them learn? ← Application

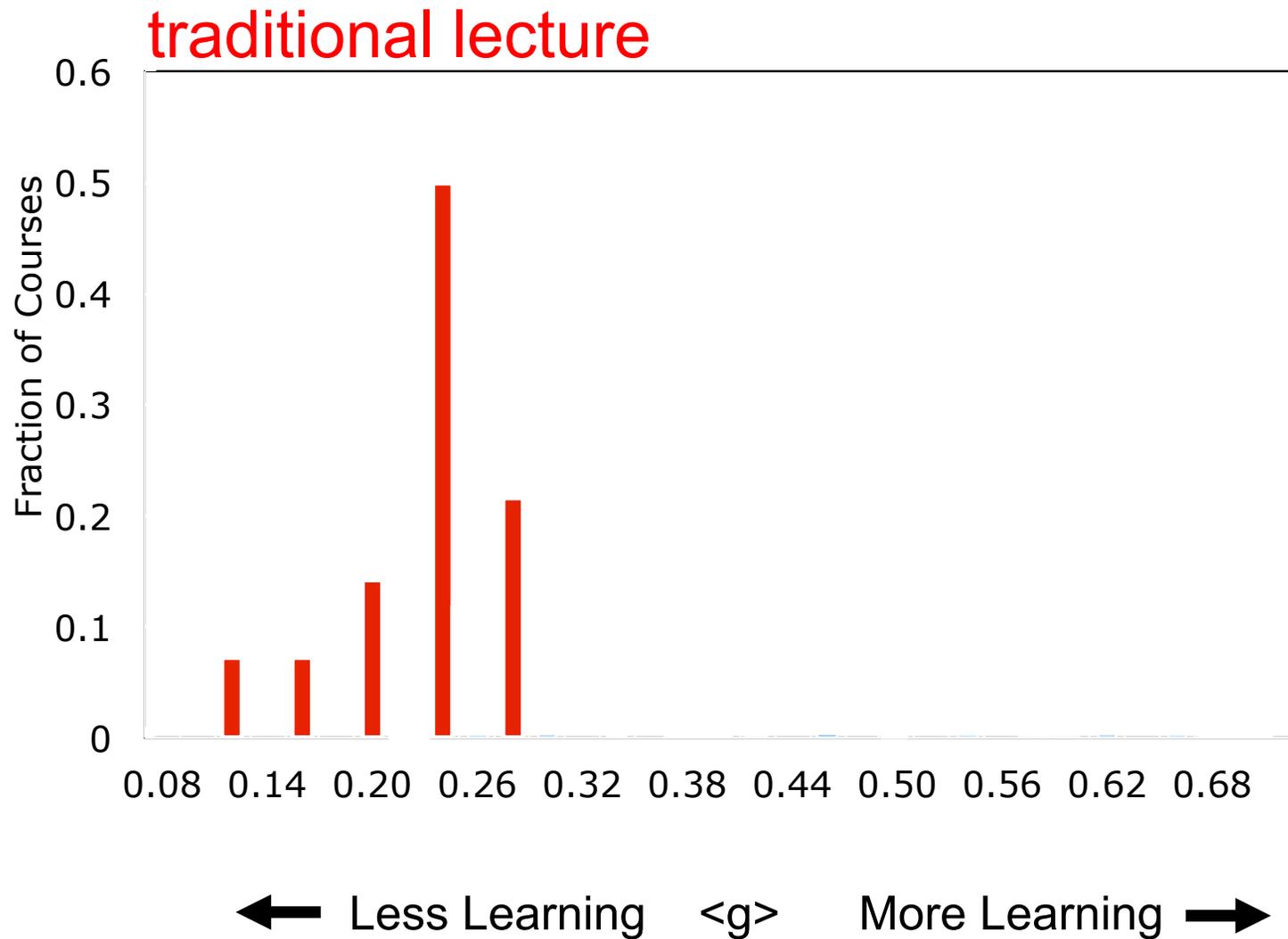
Sample question



Sample question



Force Concept Inventory Learning gains

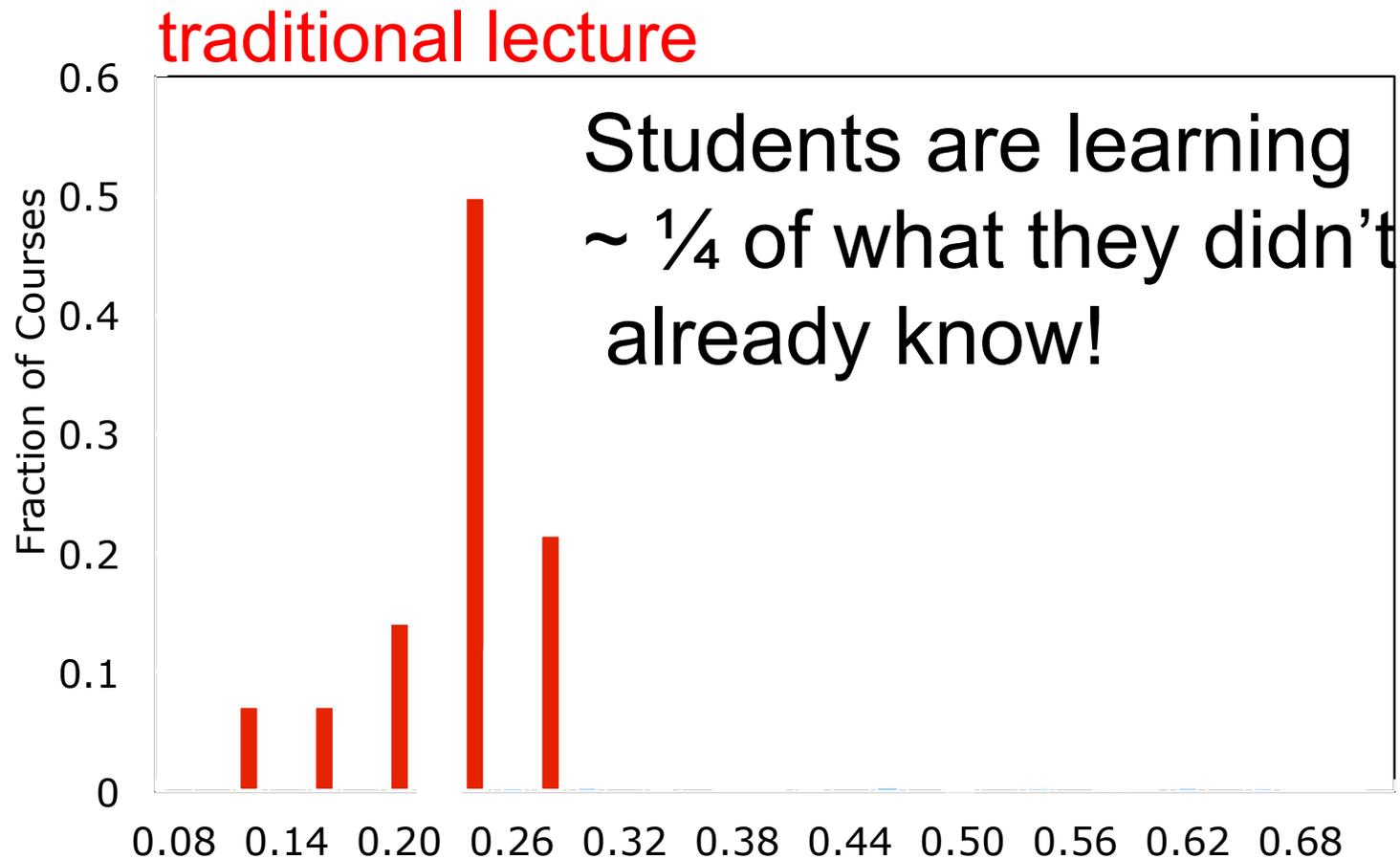


R. Hake, "...A six-thousand-student survey..." AJP 66, 64-74 ('98).

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Force Concept Inventory Learning gains

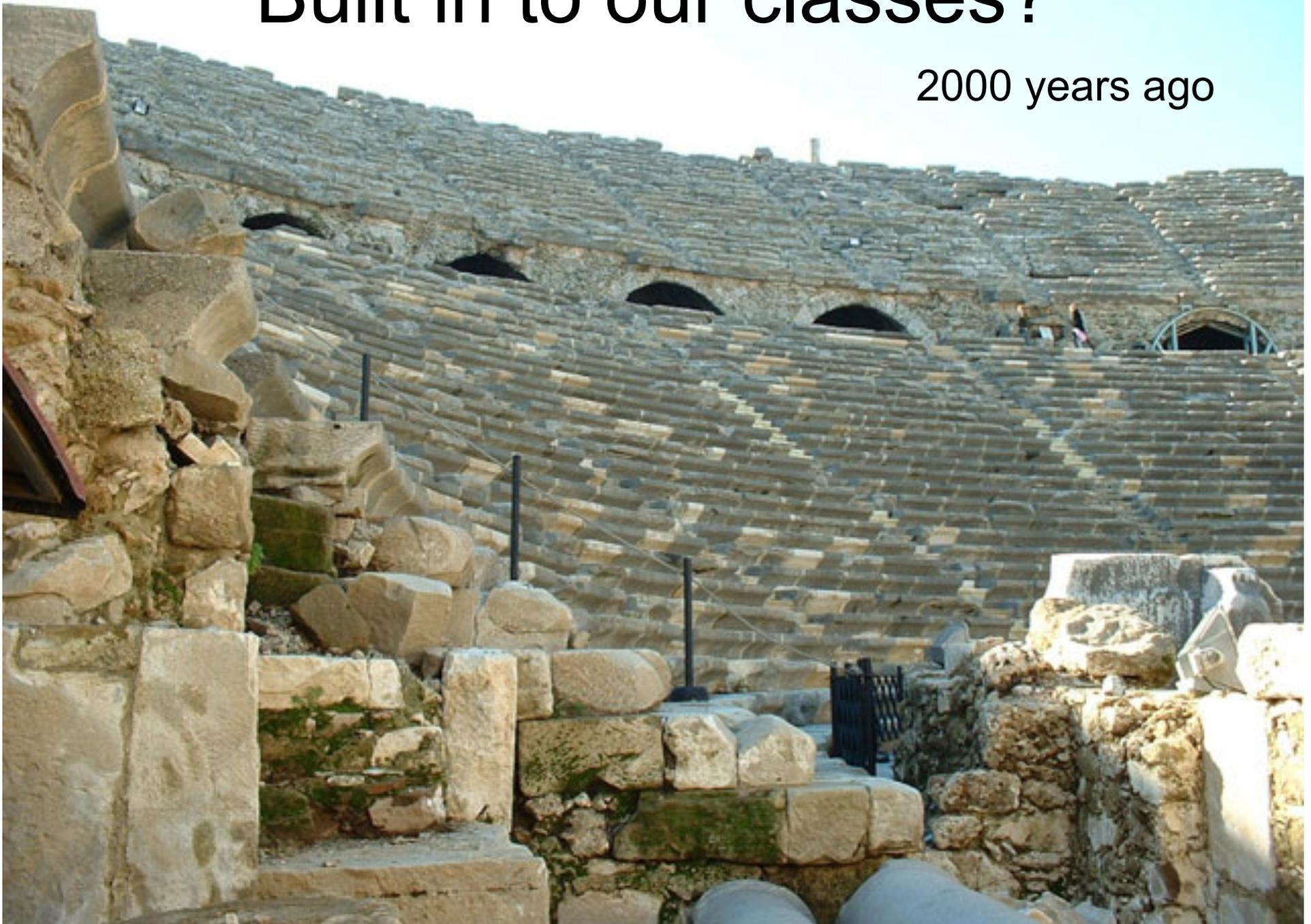


← Less Learning <g> More Learning →



Built in to our classes?

2000 years ago



Today



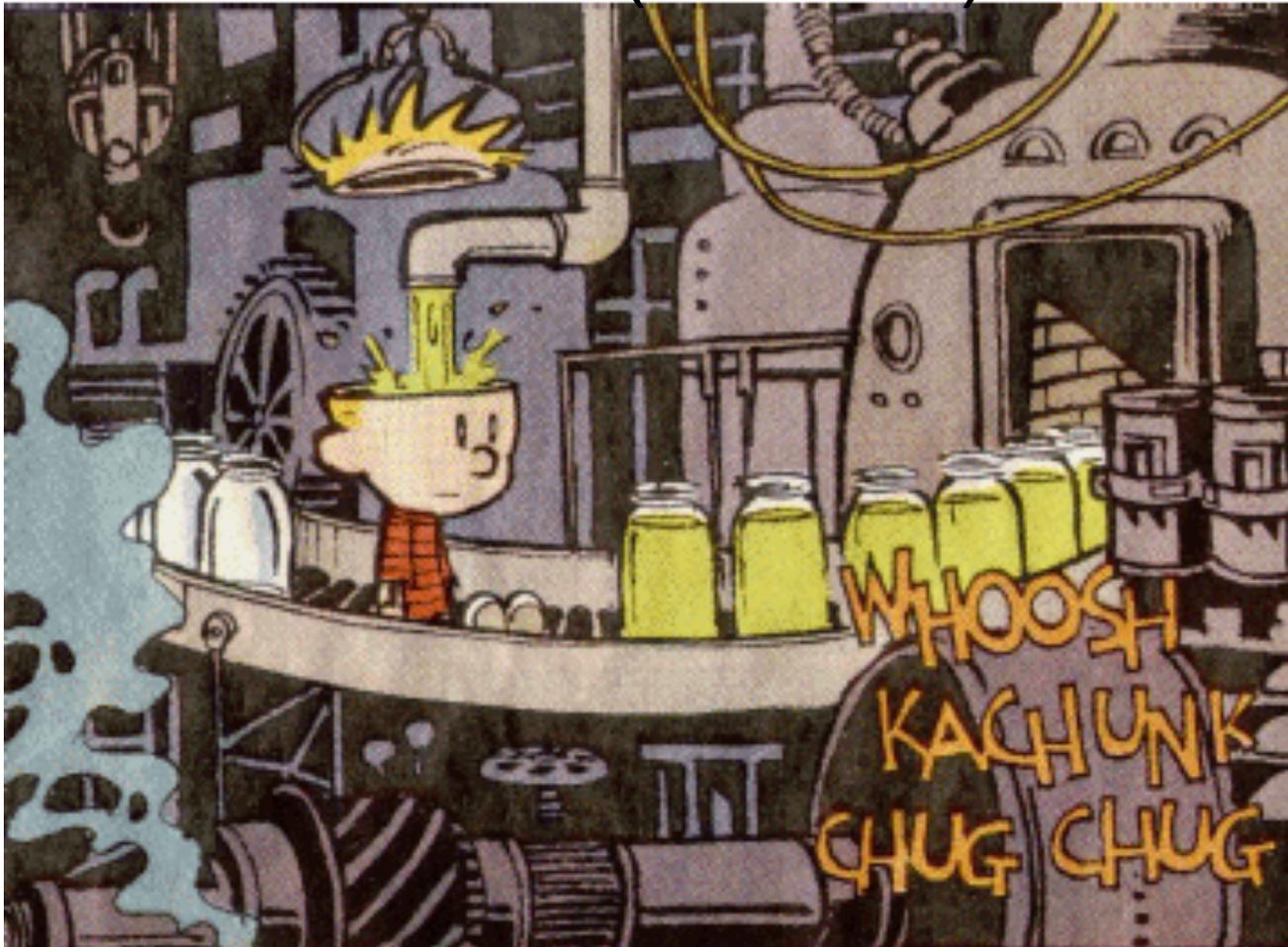
Conventional model of teaching and learning:
“transmitting knowledge”

=> lecture (efficient!)



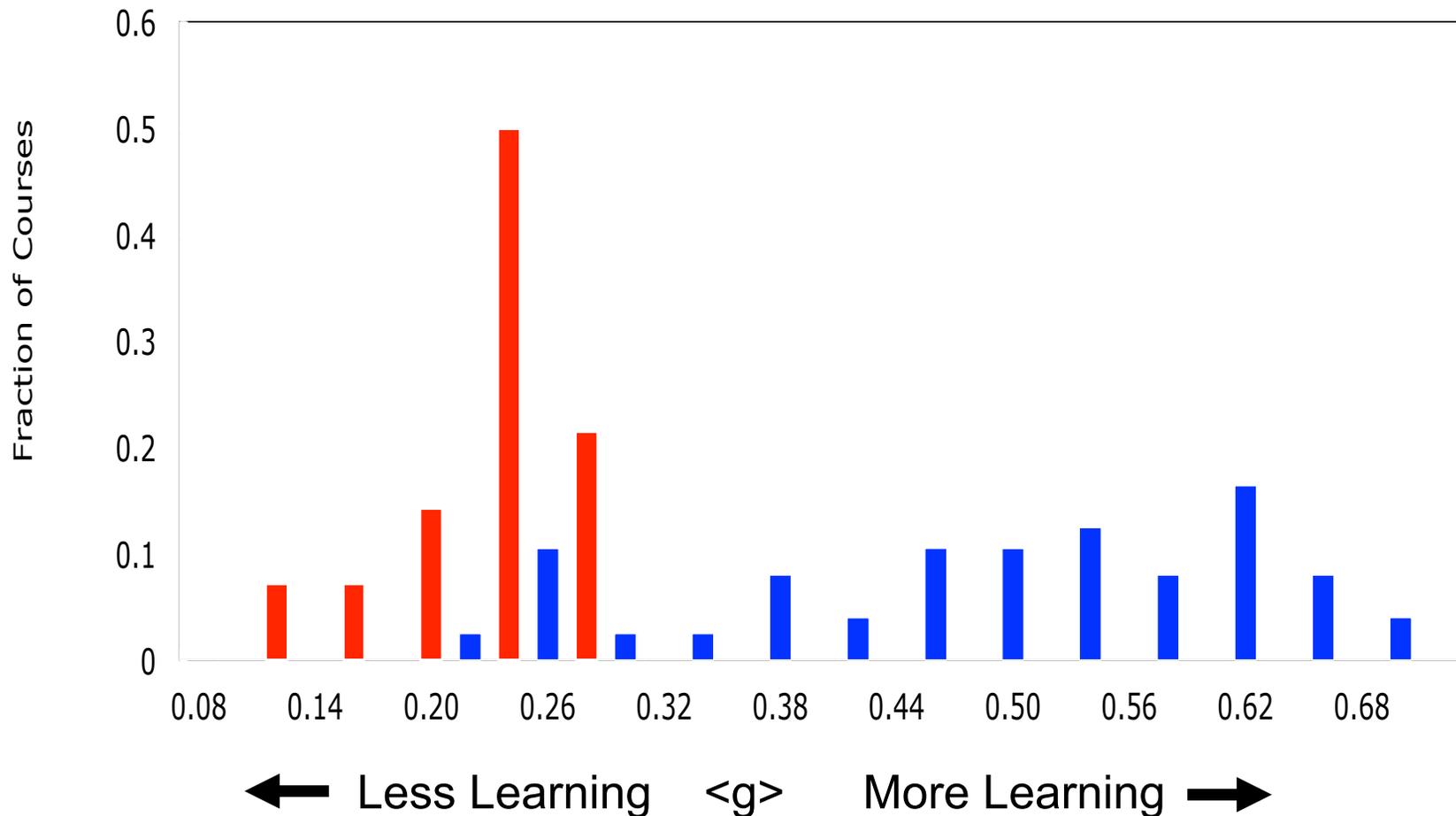
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FCI Learning gains

traditional lecture interactive engagement



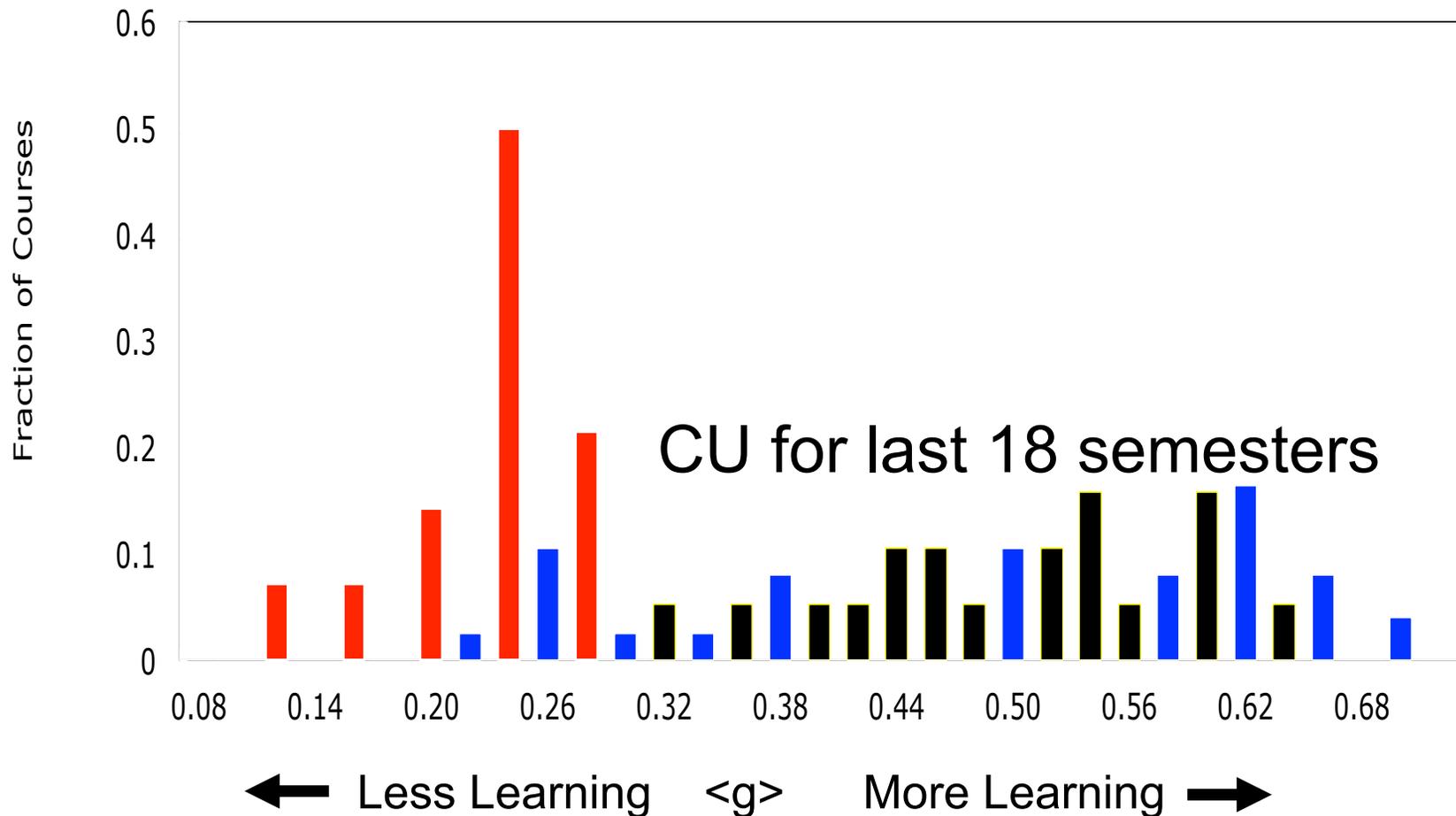
R. Hake, "...A six-thousand-student survey..." AJP 66, 64-74 ('98).

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FCI/FMCE Learning gains

traditional lecture interactive engagement



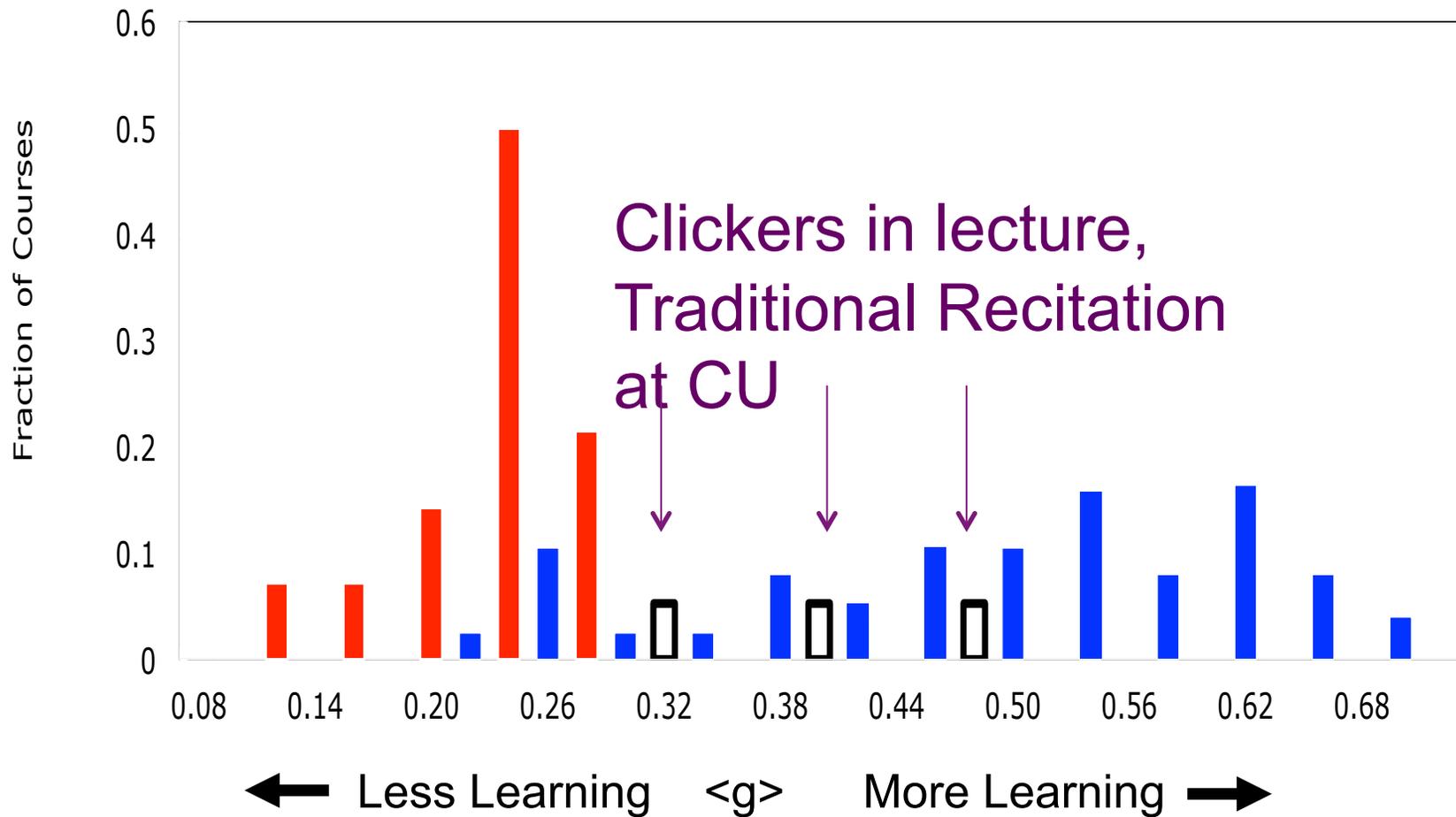
S. Pollock and N. Finkelstein,
Phys. Rev. ST Phys. Educ. Res. 4, 010110 (2008)

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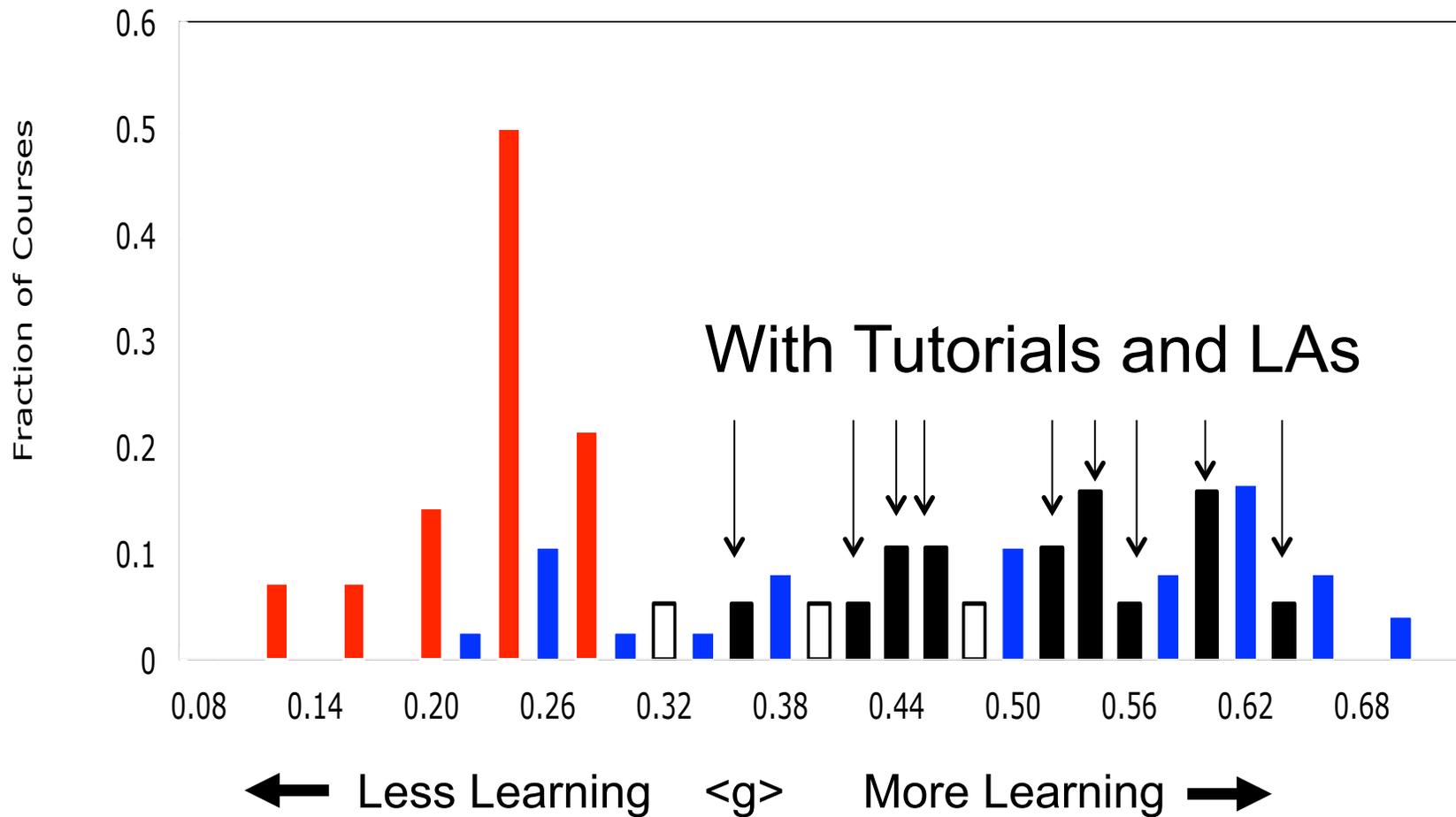
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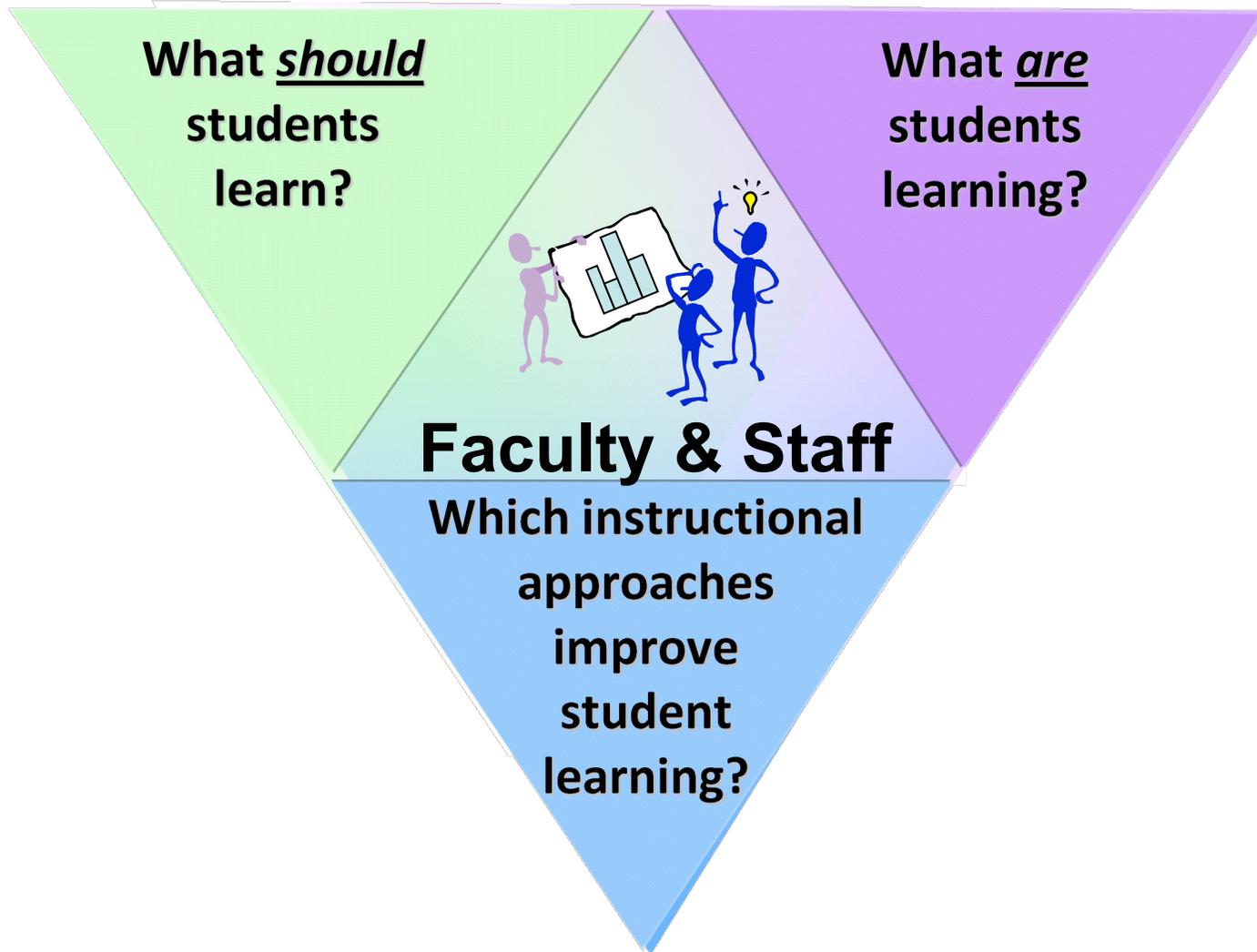
Model of Course Transformation

Chasteen, Perkins, Beale, Pollock, & Wieman, *JCST* **40** (4), 70, 2011
Chasteen et al., *AJP* **80**, 923, 2012, *PRSTPER* **8** 020108, 2012

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Model of Course Transformation

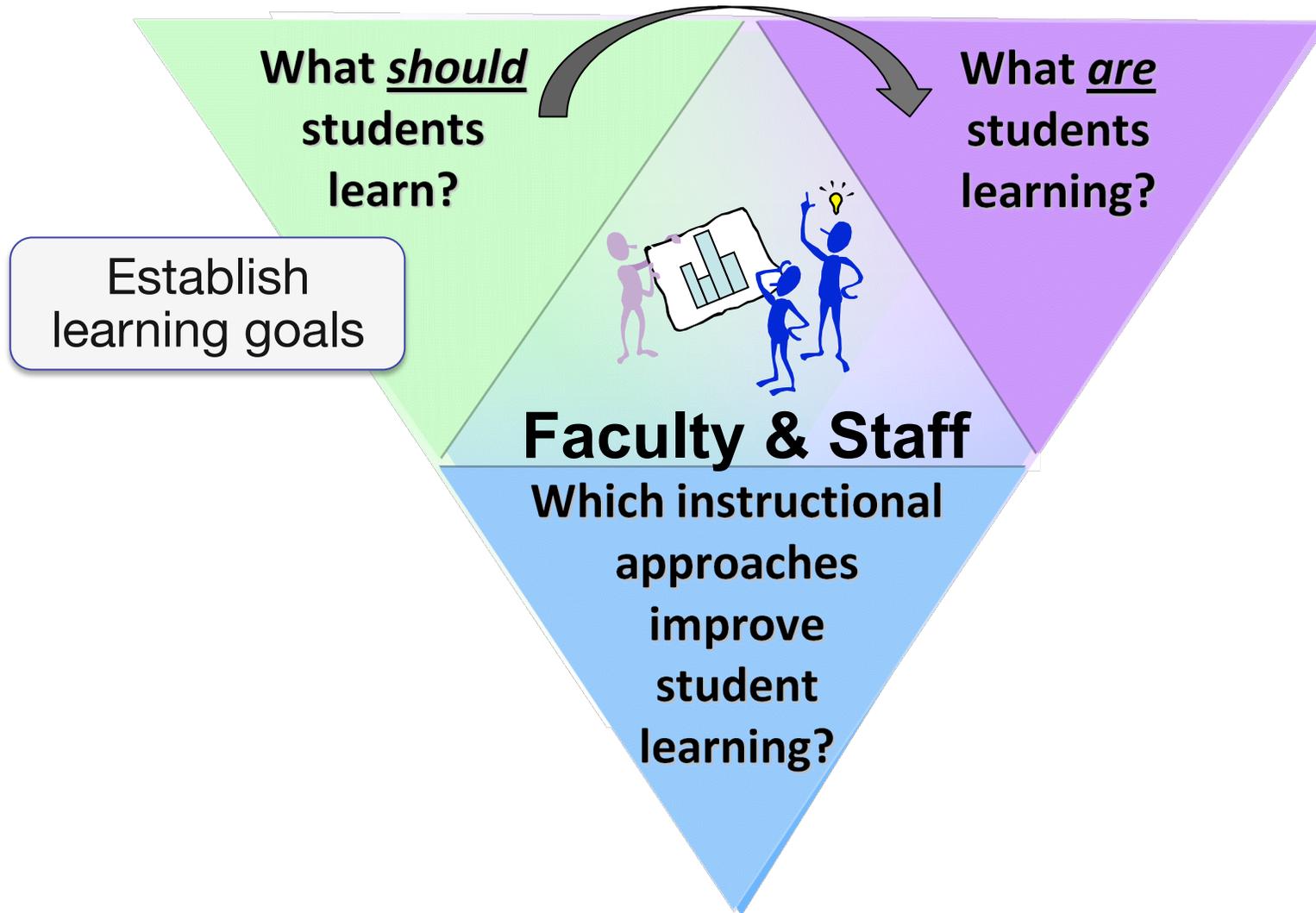


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Model of Course Transformation

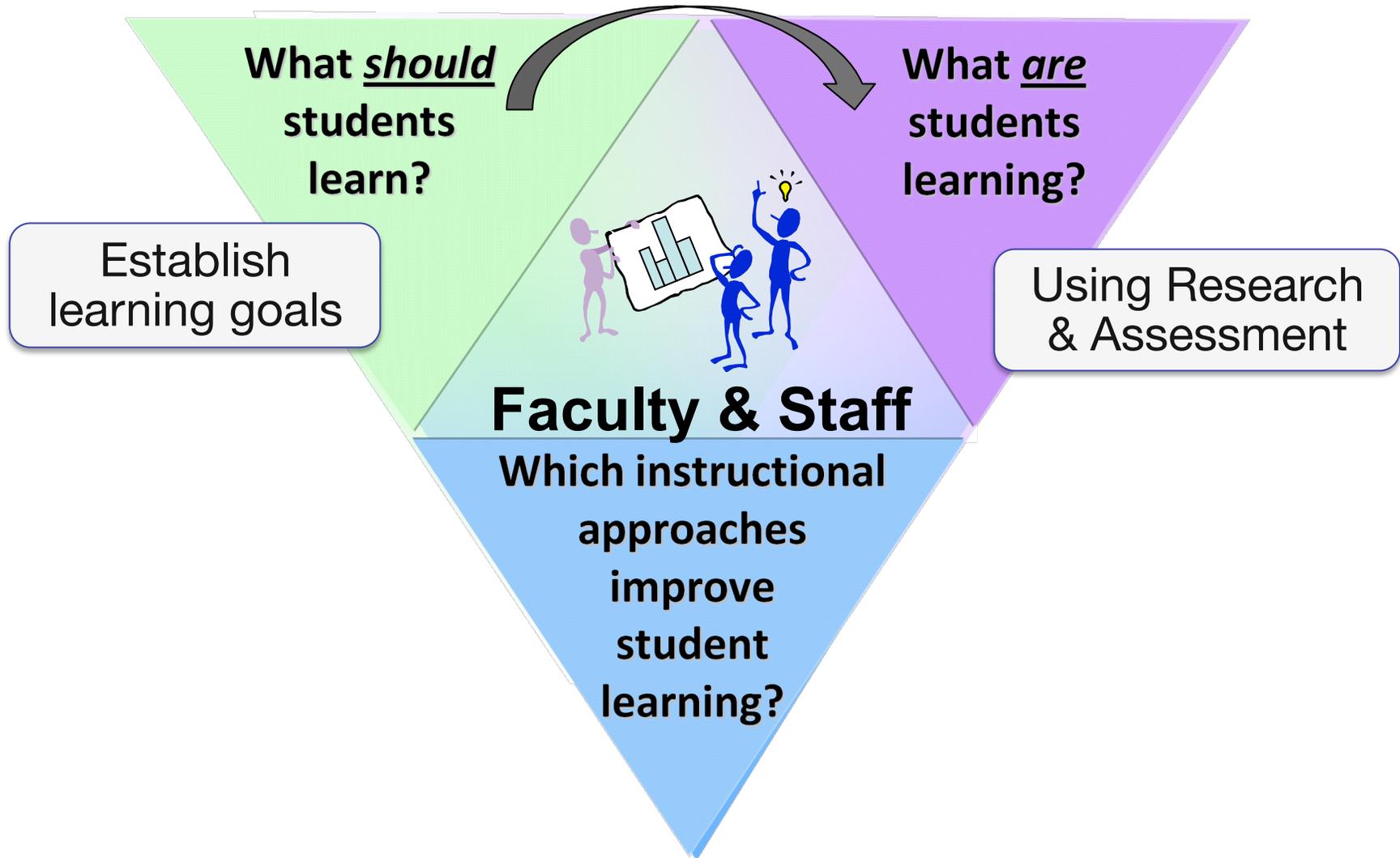


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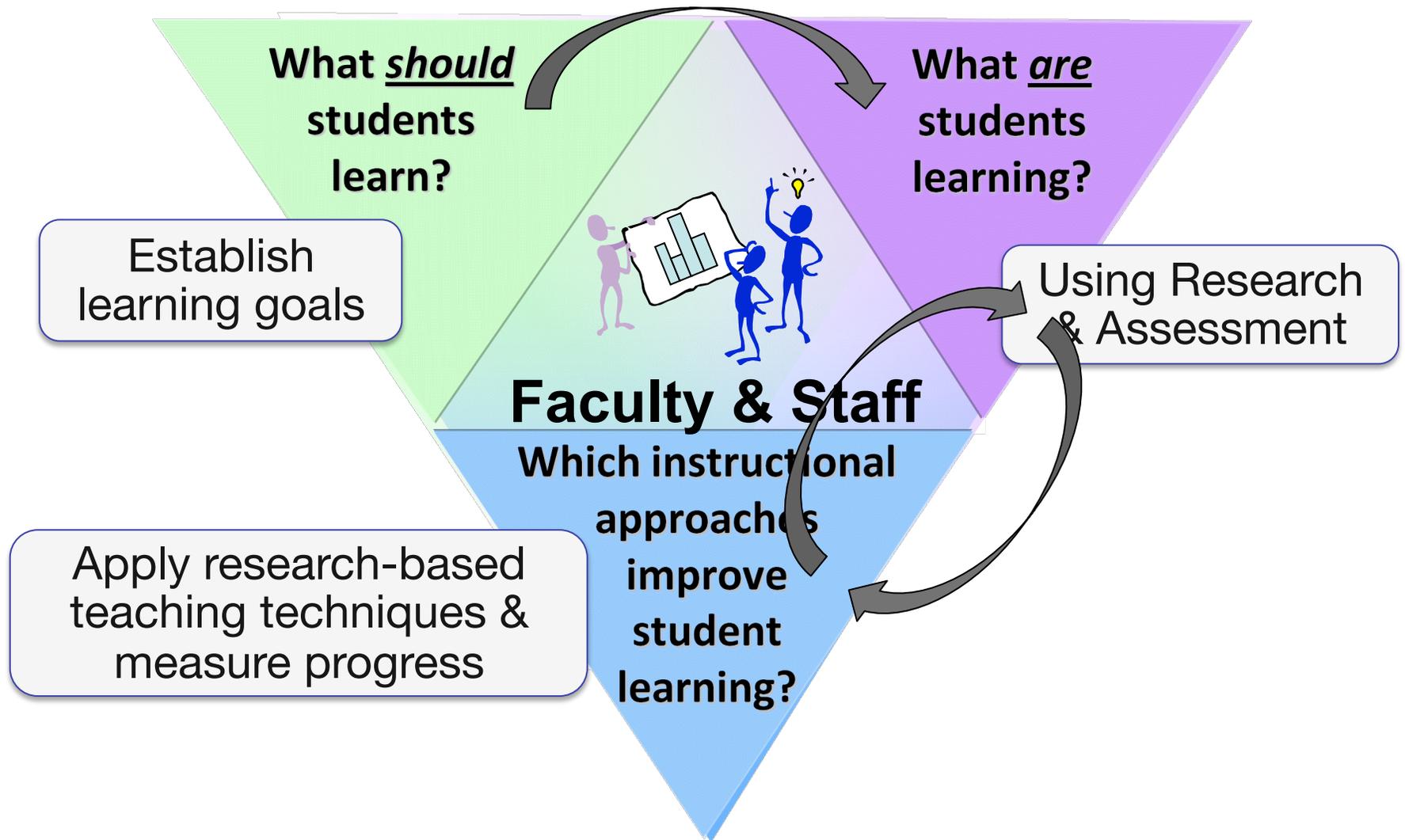


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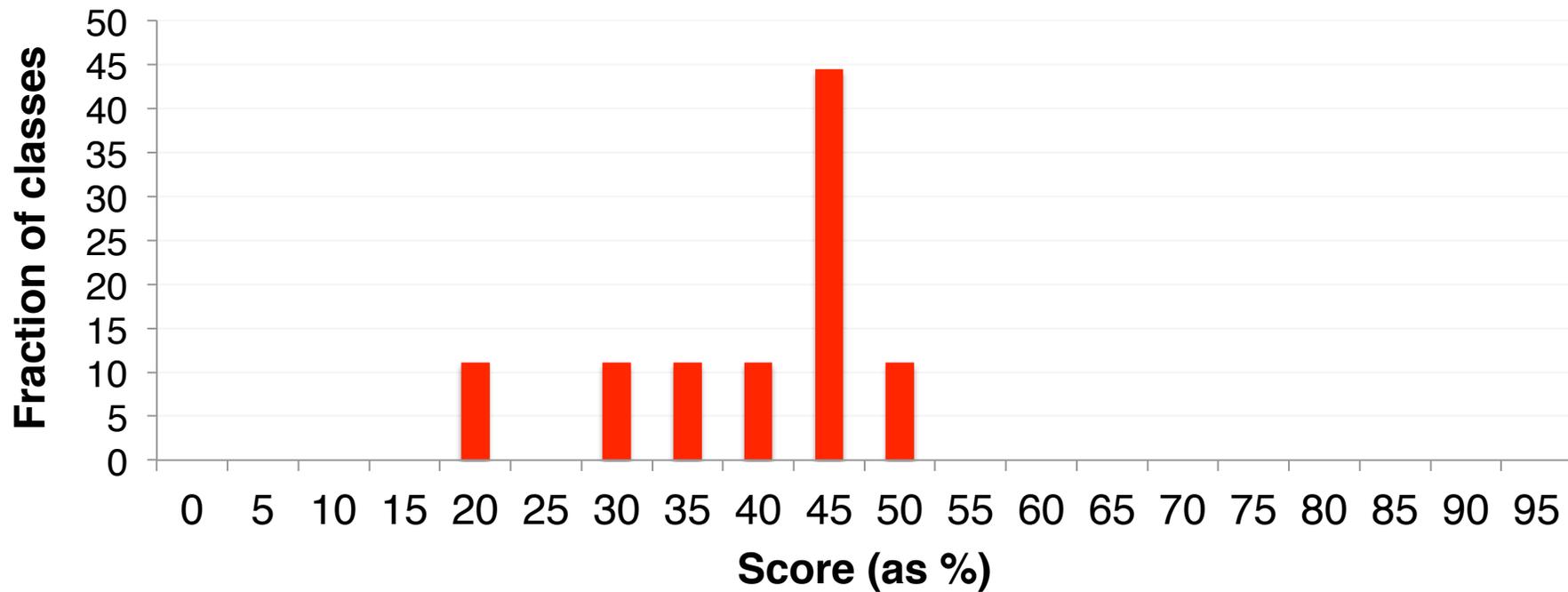


Model of Course Transformation



Upper-division conceptual test (CUE) score distribution

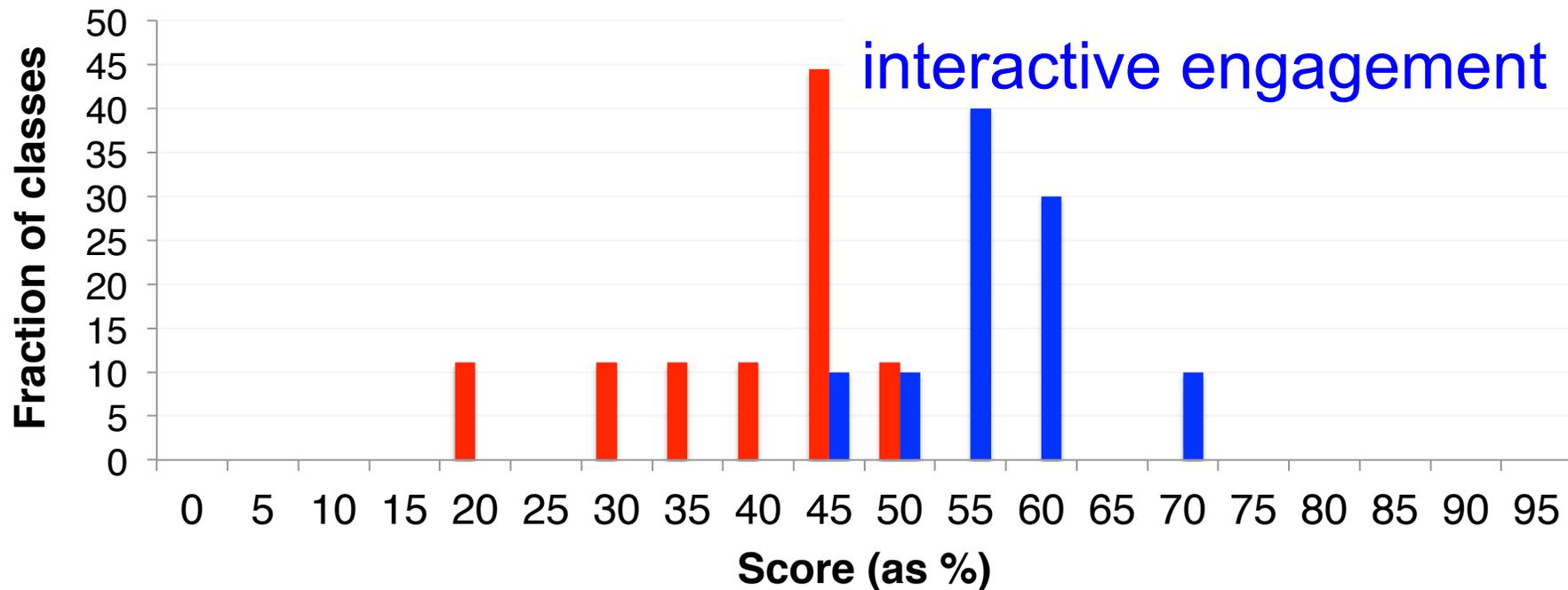
traditional lecture



$N_{\text{tot}}=540$ at 5 Universities

Upper-division conceptual test (CUE) score distribution

traditional lecture



$N_{\text{tot}}=540$ at 5 Universities, (18 classes)

New 100+ student classroom in Duane physics



DAVIS WINCE *ll*

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Summary

Kill as Few Patients as Possible



AND FIFTY-SIX OTHER
ESSAYS ON HOW TO BE
THE WORLD'S BEST DOCTOR

by Oscar London M.D., W.B.D.

Summary

- We must know our audience.

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Summary

- We must know our audience.
- Student attitudes and beliefs are important
- **Active learning works!**
- Conceptual understanding doesn't come along for free
- **It's about the *learning*.**

Kill as Few Patients as Possible



AND FIFTY-SIX OTHER
ESSAYS ON HOW TO BE
THE WORLD'S BEST DOCTOR

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Conclusions:

Teaching is an Art



Conclusions:

Teaching is an Art

~~Art~~
a Science

Conclusions:

Teaching is an Art

~~Art~~
a Science

**Teaching and Research
are *not* separate missions.**

Teaching can be improved by scholarly study!

Two-way conversations with students are vital



“Pearls Before Swine” by Stephan Pastis, 2002.

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Two-way conversations with students are vital



“Pearls Before Swine” by Stephan Pastis, 2002.

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Questions?

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