

Research-based resources on PhysPort

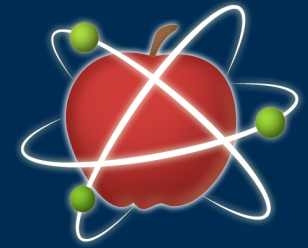
Eleanor C Sayre,
Sam McKagan,
Adrian M Madsen

NFW
November 2017

esayre@ksu.edu



DUE-1430967
DUE-1347821
DUE-1347728
PHYS-1461251



PhysPort

Supporting physics teaching with research-based resources

What is PhysPort?

A web resource to support physics professors in using research-based teaching and assessment in their classes

www.physport.org



PhysPort.org

Eleanor Sayre, esayre@ksu.edu

PhysPort Team



American Association of Physics Teachers



Sam McKagan (*Director*)
Adrian Madsen (*Assistant Director*)
Lyle Barbato (*development lead*)
Matt Riggsbee (*visual design*)



Kansas State University



Ellie Sayre (*Research Director*)
Eugene Vasserman (*security lead*)
Josh Weese (*development lead*)

Theresa Neil Design



Sandy Martinuk
(*User Experience*)

Periscope Specialists



Rachel Scherr
Stephanie Chasteen

How to compare teaching methods?

Which assessment should I use?

Faculty have big questions.

How do I prepare TAs?

How do I support diverse learners?

What works best for my context?

course

program



NFW is overwhelming.

Finding information and advice

Changing teaching practices

PhysPort can help.



Supporting physics teaching with research-based resources

Faculty-centered online resources

Synthesis research

go here now.

physport.org



PhysPort

Supporting physics teaching with research-based resources

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Home

Expert Recommendations

Teaching Methods

Assessments

Workshops

Welcome to PhysPort (formerly known as the PER User's Guide), the go-to place for physics faculty to find resources based on physics education research (PER) to support your teaching. [Learn more...](#)

Teaching

I want to...

- [find a new teaching method](#)
- [get implementation help](#)
- [learn more about research-based teaching](#)

Assessment

I want to...

- [interpret assessment results](#)
- [assess the impact of reforms](#)
- [assess advanced physics content or skills](#)

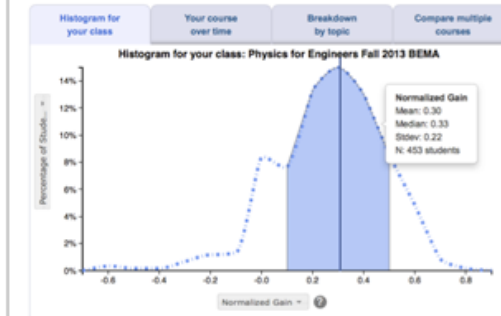
Troubleshooting

I need help with...

- [covering enough material](#)
- [supporting group work](#)
- [arguments for skeptical colleagues](#)



NEW - PhysPort Data Explorer



Explore assessment data

Where can I find good questions to use with clickers or Peer Instruction?

by Sam McKagan, PhysPort director



Expert Recommendations

physport.org/recommendations

Friendly articles that interpret and synthesize PER results for physics faculty.

The screenshot shows the PhysPort website interface. At the top, there is a navigation bar with links for Home, Expert Recommendations (highlighted), Teaching Methods, Assessments, and Workshops. The main content area is titled "Expert Recommendations" and features a "FEATURED" section with an article titled "Addressing common concerns about concept inventories" by Adrian Madsen, Sam McKagan, and Eleanor Sayre, dated July 8, 2016. To the right, there are sections for "Most Popular" and "Tags". The "Most Popular" section lists articles like "Normalized gain: What is it and when and how should I use it?" and "Arguments for skeptical colleagues". The "Tags" section includes links for "active learning", "assessment", "best practices", "clickers", "concept inventories", "cooperative groups", "Peer Instruction", "PhET Interactive Simulations", "physics education", "research", and "teaching".

Real questions.

Research-based answers.

Faculty-centered resources.

Have a suggestion?

Want to contribute?

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smckagan@aapt.org

Teaching Methods

physport.org/methods/

How do I know which way to teach?

PhysPort
Supporting physics teaching with research-based resources

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Home Expert Recommendations **Teaching Methods** Assessments Workshops

Teaching Methods and Materials

Tell us about your course to find methods relevant to you.

Any Subject Any Level Any Setting

Submit

Student Skills Developed ?
Any

- Conceptual understanding
- Problem-solving skills
- Lab skills
- Making real-world connections
- Using multiple representations
- Designing experiments
- Building models
- Metacognition

Instructor Effort Required ?
Any

55 Research-Based Methods

Sort by: Popularity

Peer Instruction

Small group discussion of conceptual questions interspersed with lectures, increasing engagement and providing formative feedback on student thinking.

Subject: Physics (+7)

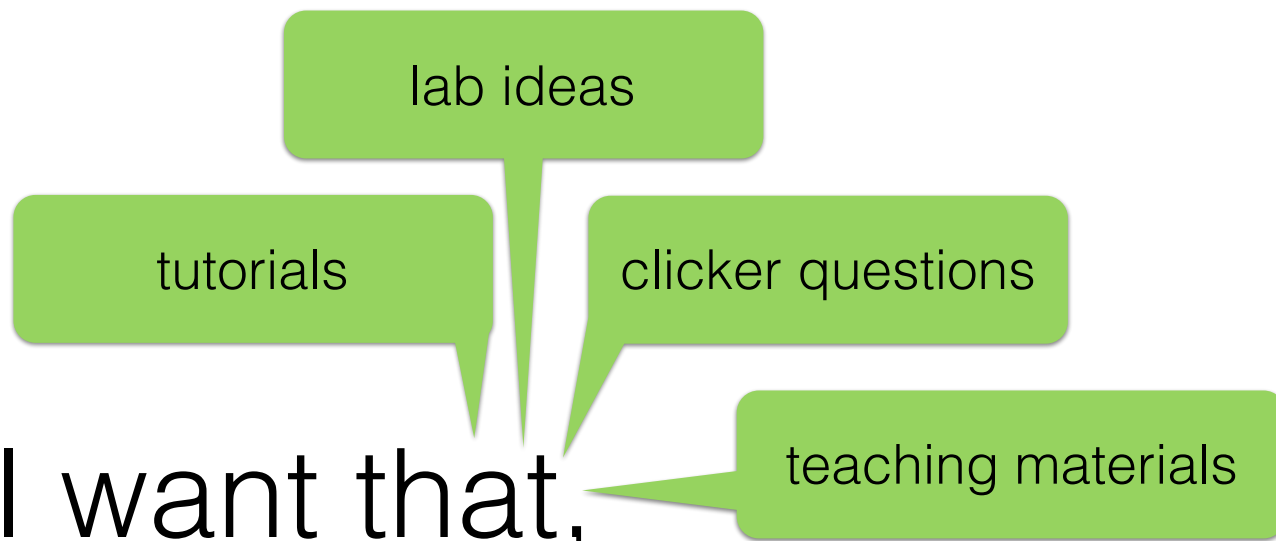
Level: MS HS IC IM UL GS O

Setting: (+2)

DhET Interactive Simulations

- Type of method
- Level & Setting
- Coverage & Topics
- Instructor Effort
- Research validation
- Compatible methods
- Similar methods
- More information

Now that I want that,
where can I get it?



Open Source Physics

www.compadre.org/osp/

The screenshot shows the Open Source Physics website. At the top, there is a navigation bar with the OSP logo and the text "open source physics". To the right, there is a welcome message for Eleanor Sayre and several links: "my profile", "AAPT link", "logout", "filing cabinet", "suggest a resource", and "administrate". Below this is a search bar with the text "Search the OSP Collection." and buttons for "Search" and "Advanced".

On the left side, there is a vertical menu with the following items: SIMULATIONS, EJS MODELING, CURRICULUM, PROGRAMMING, TOOLS, JS/HTML MATERIALS, BROWSE MATERIALS, RELATED SITES, DISCUSSION, and ABOUT OSP. Below the menu is a logo for the Science SPORC Prize, November 2011, and a small image of a globe.

The main content area is divided into several sections:

- Computational Resources for Teaching**: A section titled "The OSP Collection" provides curriculum resources that engage students in physics, computation, and computer modeling. It mentions that computational physics and computer modeling provide students with new ways to understand, describe, explain, and predict physical phenomena. It also mentions browsing the OSP simulations or learning more about tools and curriculum pieces.
- Tracker**: A section describing the Tracker tool, which extends traditional video analysis by enabling users to create particle models based on Newton's laws. It notes that models synchronize with and draw themselves right on videos of real-world objects, allowing students to test models experimentally by direct visual inspection. A link "Learn more about Tracker" is provided.
- EJS Modeling**: A section describing student modeling, the guided exploration of physical systems and concepts, as a powerful approach to engaged learning. It mentions that Easy Java Simulations provides computational tools for students and faculty to explore physics without the need for learning details of java programming. A link "Learn more about EJS" is provided.
- Programming**: A section stating that Open Source Physics provides extensive resources for computational physics and physics simulations. It includes a list of included resources.


On the right side, there are two more sections:

- Newest OSP Materials**: A list of materials with dates and titles:
 - May 26: Physlet® Waves and Oscillations Problem Package
 - May 24: Physlet® Physics Periodic Motion Problems JS Package
 - May 13: Solar and Lunar Eclipse JS Model
 - Apr 24: Celestial Sphere with Analemma JS Model
- Recently Updated Materials**: A list of materials with dates and titles:
 - Jun 10: STP Textbook Chapter 9: Critical Phenomena
 - Jun 10: STP Textbook Errata supplement
 - May 8: Two-Body Orbits JS Model
 - Mar 20: Open Source Physics Users Guide supplement

parallel session

Advanced Labs

www.compadre.org/advlabs/




AAPT Advanced Labs

PHYSICS EDUCATION


[my profile](#) - [logout](#)
[filing cabinet](#) - [suggest a resource](#) - [administrate](#)

[Home](#) | [Lab Manuals](#) | [Software](#) | [Supplements](#) | [Forums](#) | [Conferences](#) | [ALPhA](#) | [Listserv](#) | [About](#)




Information Exchange

- [Lab Manuals](#)
- [Software](#)
- [Supplements](#)




News and Events








[AAPT Summer Meeting 2017](#)

Preparations are underway for the AAPT Summer meeting in Cincinnati, Ohio (July 22-26, 2017). The meeting will be held at the RiverCenter Convention Center. The main conference hotel is the Marriott Cincinnati RiverCenter. .




Featured Folders

-  [AAPT 2013 Advanced Labs Workshop](#)
 - Low-Cost Capacitance Profiling of a Semiconductor
 - Multimode fiber optics
 - Temperature Dependent Lifetime Measurements of Fluorescence from a Phosphor
 - Cosmic Ray Statistics using LabVIEW
 - 532 nm Laser Lab
-  [AAPT 2012 Advanced Labs Workshop](#)
-  [AAPT 2011 Advanced Labs Workshop](#)
-  [AAPT 2010 Advanced Labs Workshop](#)



Recently Added Materials

- May 10 [Interferometric Faraday effect magnetic field measurements](#)
- May 10 [Interferometric Faraday effect magnetic field measurements](#)
- May 10 [Spin Noise Spectroscopy in Rb Vapor](#)
- May 10 [2016 AAPT-ALPhA Award Lab Manual](#)
- Apr 26 [2016 AAPT-ALPhA Award - The Hong-Ou-Mandel Effect](#)
- Apr 25 [2015 AAPT-ALPhA Award - Mechanical Chaotic Oscillator](#)
- Apr 25 [Investigating student ownership of projects in an upper-division physics lab course](#)



Filing cabinet

bit.ly/compadre-nfw

NFW collection
Make your own
collections!

AAPT ComPADRE
Resources and Services for Physics Education

[filing cabinet](#) - [logout](#) - [help](#)

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The AAPT ComPADRE Collections | [Events](#) | [Collaborative Community Services](#)

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[Bruce, ComPADRE Dir's Shared Folder](#) [My Folders](#)

[Bruce, ComPADRE Dir's Shared Folders](#)

- New Faculty Workshop - Digital Libraries

New Faculty Workshop - Digital Libraries (4 resources, [10 subfolders](#))
This folder contains materials for participants in the the New Faculty Workshop. These materials are updated for each workshop, with new highlights added from time to time.

The folders below sort the content by subject and type.

- Interactive Video Vignettes**
Online video tutorials with interactive questioning and video analysis. This material includes a tool to build your own tutorial.
[details](#) - [website](#)
- PhET: Physics Education Technology**
PhET provides a collection of research-based simulations in physics, chemistry, math, and biology. These carefully designed immersive

Assessment Resources

physport.org/assessments

How do I know if my students are learning?

These are:

- Generally multiple-choice surveys
- Carefully crafted questions
- Conceptual topics across physics curriculum
- Additionally: beliefs, problem-solving skills, affect

80+ available

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Supporting physics teaching with research-based resources

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Home | Expert Recommendations | Teaching Methods | **Assessments** | Workshops

Browse Assessments

Tell us about your course to find assessments relevant to you.

Any Subject | Any Level | Submit

Assessment Focus
Any

- Content knowledge
- Problem-solving
- Scientific reasoning
- Lab skills
- Beliefs / Attitudes
- Interactive teaching

Format
Any

- Pre/post ?
- Multiple-choice
- Multiple-response ?
- Agree/disagree ?
- Short answer
- Rubric ?

82 Research-Based Assessments

Sort by: Research validator

- Force Concept Inventory (FCI)**
Mechanics Content knowledge (forces, kinematics)
Levels: Intro college, High school
Formats: Pre/post, Multiple-choice
30 min
- Colorado Learning Attitudes about Science Survey (CLASS)**
Beliefs / Attitudes (epistemological beliefs)
Levels: Upper-level, Intermediate, Intro college, High school
Formats: Pre/post, Multiple-choice, Agree/disagree
8-10 min
- Brief Electricity and Magnetism Assessment (BEMA)**

Assessment Resources

physport.org/assessments

How do I know if my students are learning?

- Search for RBAs
- Get administration details
- Sample questions & typical results
- Download RBAs
- Download usage guides

Verified educators!

For faculty and
teaching staff
free, easy

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Browse Assessments

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Any Subject | Any Level | Submit

Assessment Focus
Any







- Content knowledge
- Problem-solving
- Scientific reasoning
- Lab skills
- Beliefs / Attitudes
- Interactive teaching

Format
Any

- Pre/post ?
- Multiple-choice
- Multiple-response ?
- Agree/disagree ?
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- Rubric ?

82 Research-Based Assessments

Sort by: Research validator

	Force Concept Inventory (FCI) Mechanics Content knowledge (forces, kinematics) Levels: Intro college, High school Formats: Pre/post, Multiple-choice	 30 min
	Colorado Learning Attitudes about Science Survey (CLASS) Beliefs / Attitudes (epistemological beliefs) Levels: Upper-level, Intermediate, Intro college, High school Formats: Pre/post, Multiple-choice, Agree/disagree	 8-10 min
	Brief Electricity and Magnetism Assessment (BEMA)	

Force Concept Inventory

RESEARCH VALIDATION SUMMARY

Based on Research Into:

- ✓ Student thinking

Studied Using:

- ✓ Student interviews
- ✓ Expert review
- ✓ Appropriate statistical analysis

Research Conducted:

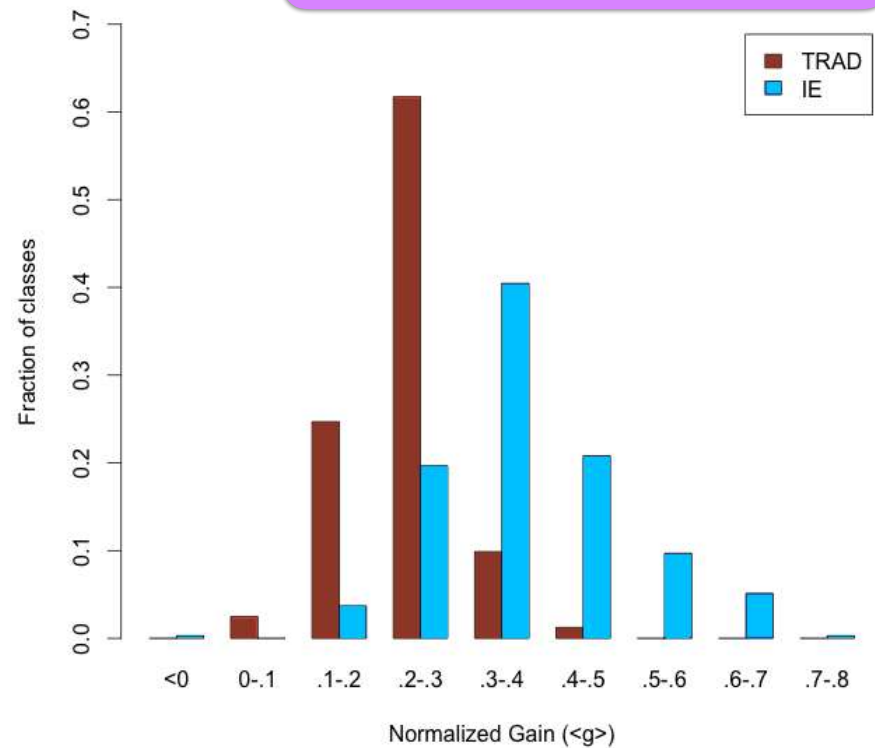
- ✓ At multiple institutions
- ✓ By multiple research groups
- ✓ Peer-reviewed publication

About half of the questions on the FCI come from an earlier test called the Mechanics Diagnostic Test (MDT). Questions on the MDT were developed using students ideas from open-ended responses. These questions were then reviewed by experts, refined through student interviews and given to over 1000 students. Statistical analysis of the reliability of the MDT was conducted and the pre- and post-test were found to be highly reliable. For those FCI questions not taken directly from the MDT, open-ended responses and responses given by students in interviews were compared to ensure the questions were being interpreted correctly. Since its release, over 50 studies have been published using the FCI at both the high school and college

including data on... able is the study scores based on 1000 students.

Research summary

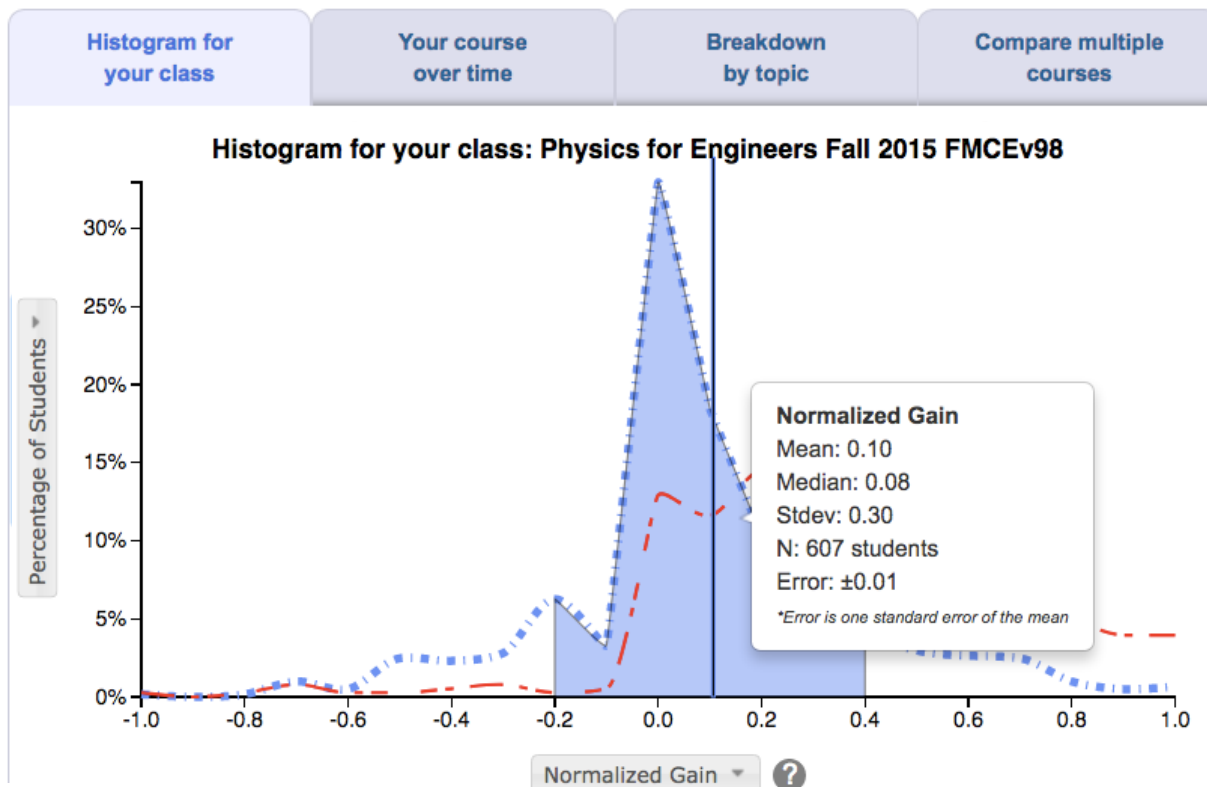
Typical results



Data Explorer

physport.org/DataExplorer

Visualize and compare your students' performance on research-based assessment instruments.



Upload your data

Explore your data

Download a report



Online workshops

physport.org/workshops

Video workshops for training teaching assistants and faculty professional development in best practices



New Faculty Workshop - Introduction
Techniques for all size classes

AAPT Virtual New Faculty Workshop
What is the Virtual New Faculty Workshop?
Videos of presentations from the live Workshop for New Faculty



What is Periscope?

Periscope: Looking into Learning
What is Periscope?
A collection of lessons for faculty and LAs/TAs to:

- watch and discuss videos of best-practices physics classrooms
- apply lessons learned to actual teaching situations
- practice interpreting student behavior
- become more effective teachers

Find the Periscope video collection at <http://PhysPort.org/periscope>

Learner-Centered Inst and Astronomy
Dr. Edward Phather, Univers



Periscope

physport.org/periscope

Videos of students working with handouts for training TAs and faculty in best-practices.

How can I best facilitate a student discussion?

Part of the Periscope collection

What is Periscope? [View Facilitators Guide](#)

1 Watch classroom video 2 Discuss in small groups 3 Discuss with whole group

Some physics classes intersperse collaborative work in small groups with whole-class discussions. The purpose of these whole-class discussions is for students to share their small group's work, appreciate other groups' work, and collaborate to increase everyone's understanding. How should instructors facilitate student discussions?

[Download Lesson What's in this?](#)

Self Study
You can also use Periscope lessons for self-study by watching the video episode and reflecting on the sample discussion prompts. In this case, we recommend printing out the handout so that you can easily refer to it while watching the episode, or opening both the episode and the handout on a large screen.

Periscope
Looking into learning
with hands-on activities, discussions, and modeling instruction

Episode 502: "Moving box"

FIU


0:00 / 2:39

Open handout in new window

This episode shows a group of about twenty students in a Modeling Instruction "board meeting," in which students who just presented their work share a question that came up for them in their analysis. Sample discussion prompts are about how the instructor facilitates the student discussion.

HANDOUT
How can I best facilitate a student discussion?

Introduction
Some physics classes intersperse collaborative work in small groups with whole-class discussions. The purpose of these whole-class discussions is for students to share their small group's work, appreciate other groups' work, and collaborate to increase everyone's understanding. How should instructors facilitate student discussions?



Episode: "Moving box"

(from University Modeling Instruction)

Task for students
A block is placed against the vertical front of a cart as shown in the figure. What acceleration must the cart have so that block... The coefficient of static friction between the block...

Sample discussion prompts

1. **What did you observe** in this episode? Talk to...
2. The instructor (Leon) has been quiet for a while **he do while he is not talking?** What messag...

Available now!
66 lessons
Facilitators' Guide

What do you want to do?

- A. I have questions like "what's available for..." and "how do I...".
I want to explore resources on PhysPort and ComPADRE on my device.
- B. I want to try a Periscope lesson about
"What instructor behaviors facilitate student learning?"
- C. I want to have a discussion around questions like
"What do we know about...". Please show me more data!
- D. My brain is full and I want some time to process what we've done.

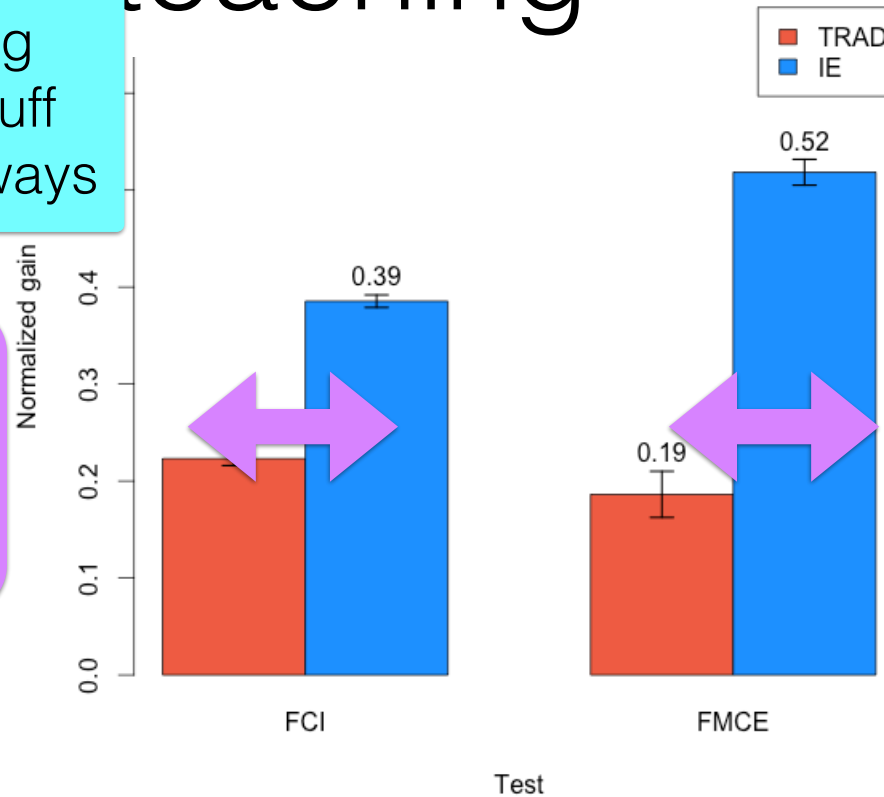
Data

Mechanics teaching

active learning
students do stuff
many different ways

Interactive
engagement
is better than
traditional lecture

chalk-and-talk
sage on the stage
cookbook labs



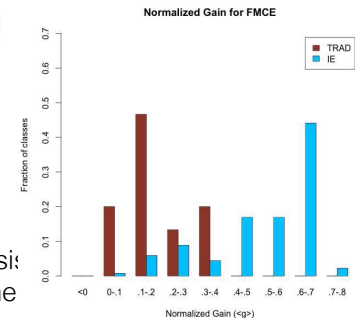
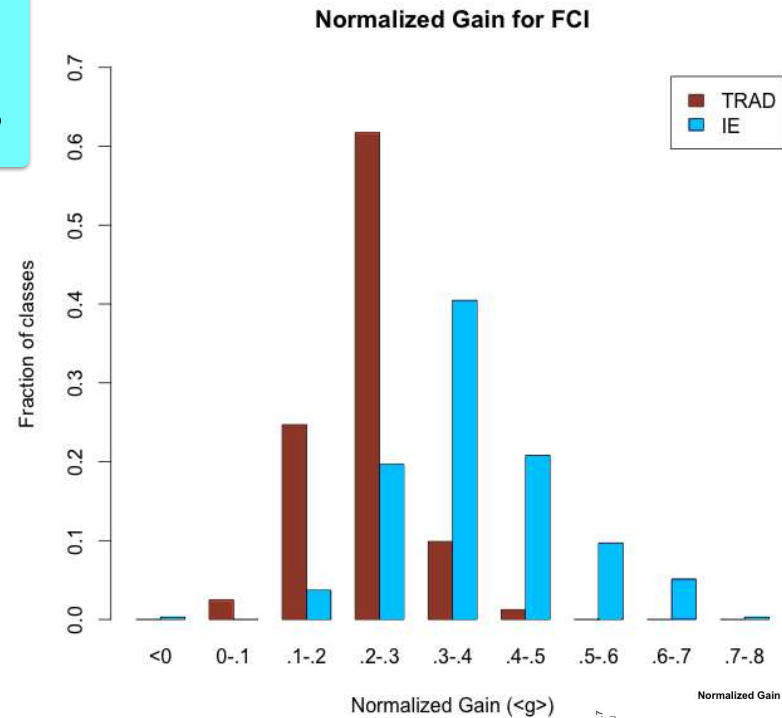
50,000 Students

Mechanics teaching

active learning
students do stuff
many different ways

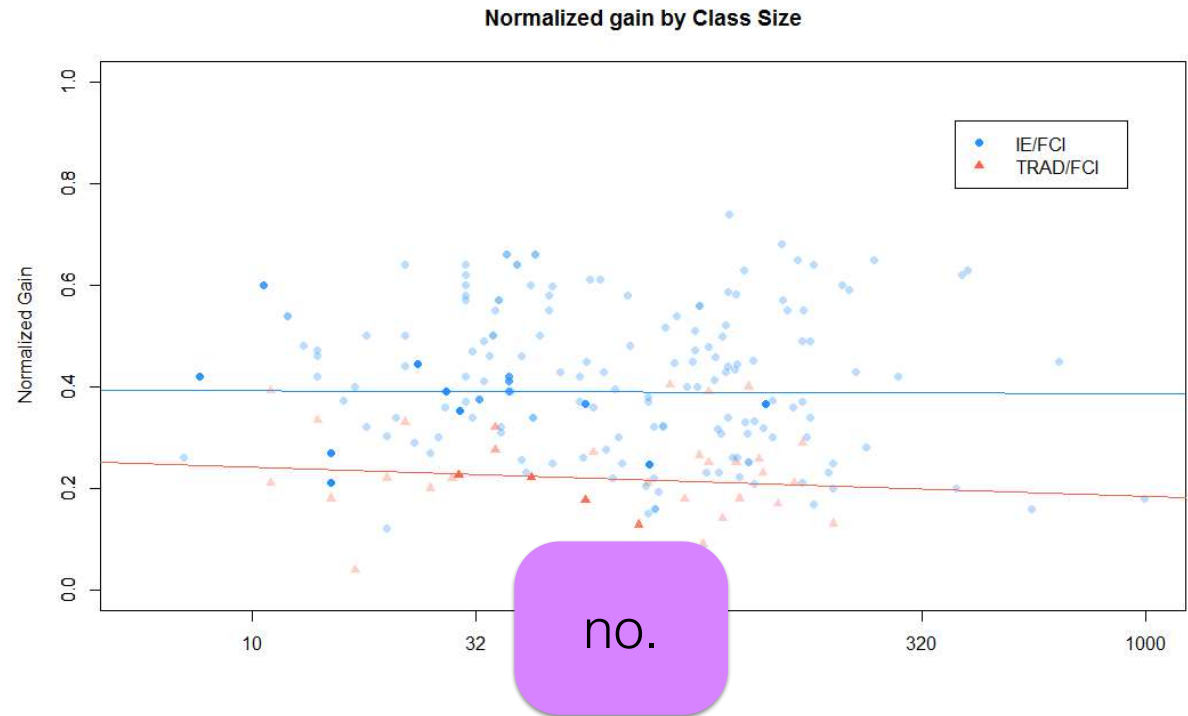
Interactive
engagement
is better than
traditional lecture

chalk-and-talk
sage on the stage
cookbook labs



Does class size matter?

- Different sizes use different IE methods.
- Same trend for lecture and lab

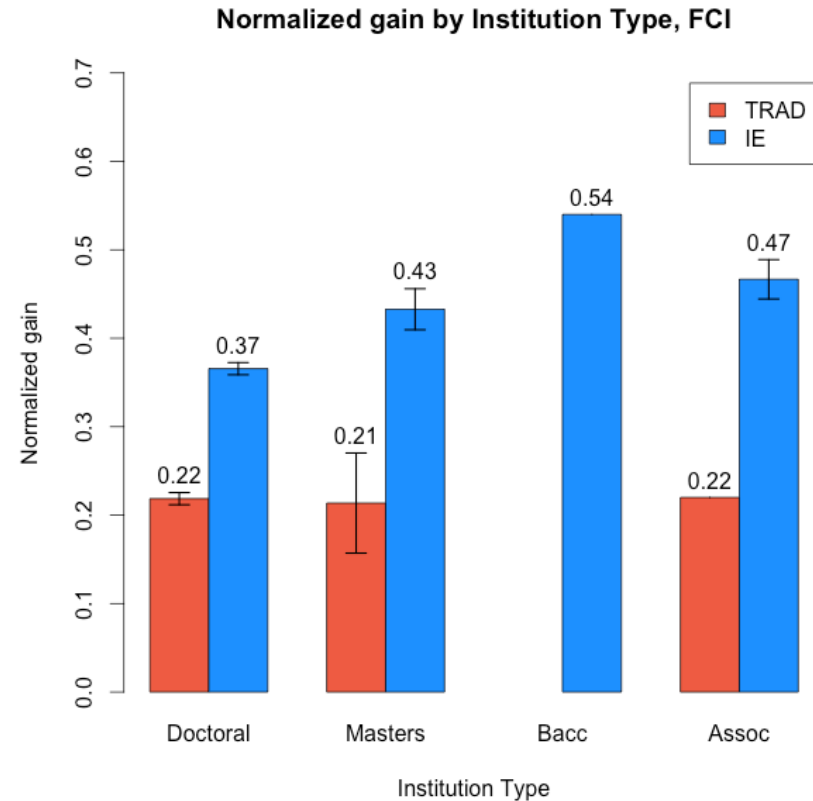


Does institution type matter?

- Reduced Carnegie classification
- Only US schools

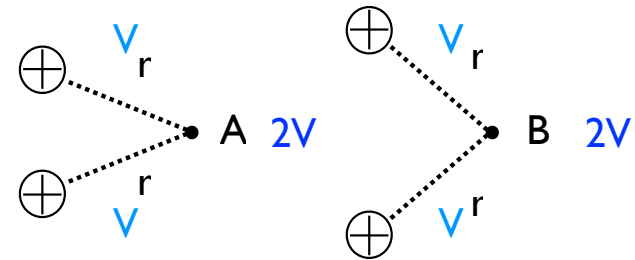
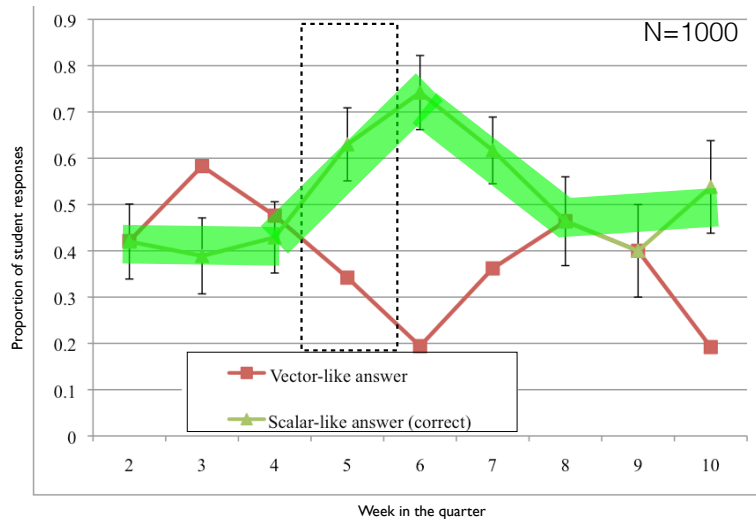
no.

- Highly dependent on publishing effect
- Data are mostly Doc institutions.



Different teaching methods

OSU Traditional course

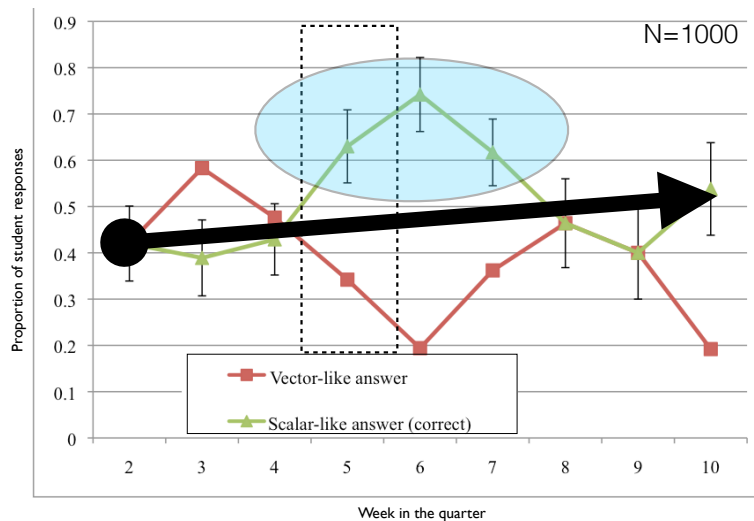


At which point is the Electric Potential greater?

$$V_A = V_B$$

Different teaching methods

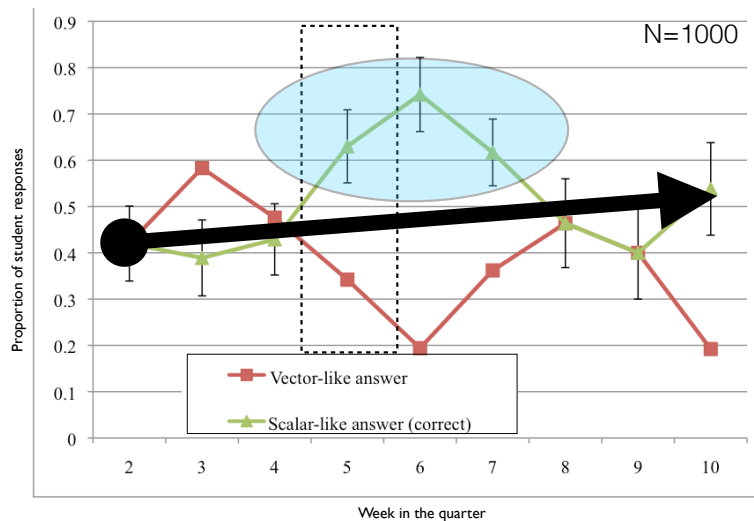
OSU Traditional course



$$\langle g \rangle = 0.25$$

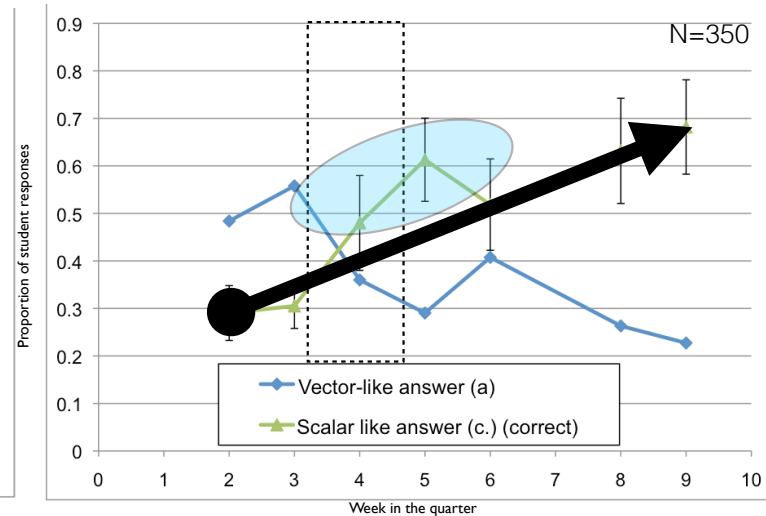
Different teaching methods

OSU Traditional course



$$\langle g \rangle = 0.25$$

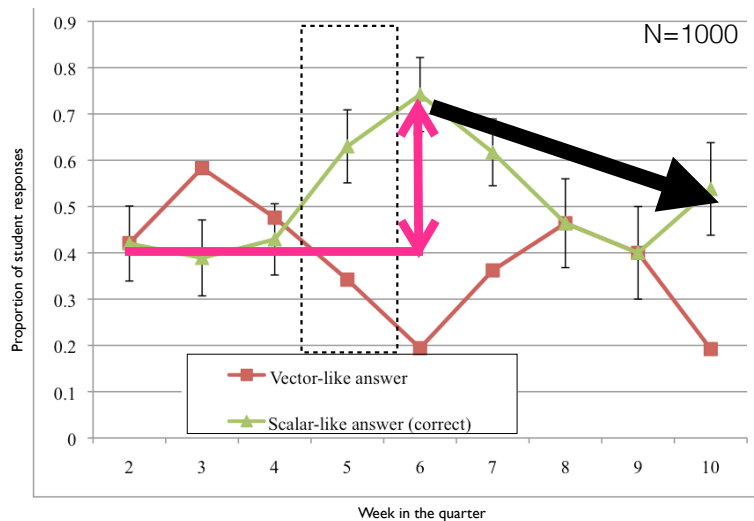
RIT Workshop course



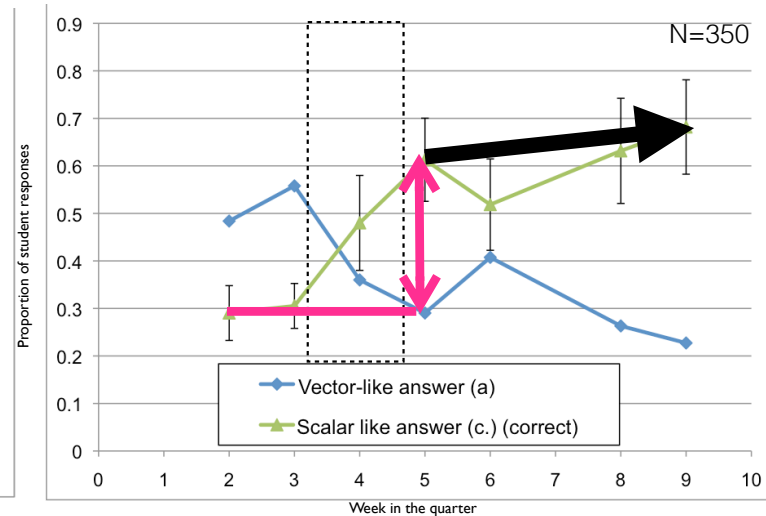
$$\langle g \rangle = 0.5$$

Different teaching methods

OSU Traditional course



RIT Workshop course



Both classes learn the same amount during instruction, but the reformed class fails to forget afterwards.

Surveys of student beliefs about physics

- How much do students' beliefs align with physicists?
- Measure **shifts** in physicist-like belief
- CLASS, MPEX

12 beliefs and attitudes surveys available on PhysPort!

Survey

1. A significant problem in learning physics is being able to memorize all the information I need to know.

Strongly Disagree | 1 2 3 4 5 | Strongly Agree

2. When I am solving a physics problem, I try to decide what would be a reasonable value for the answer.

Strongly Disagree | 1 2 3 4 5 | Strongly Agree

3. I think about the physics I experience in everyday life.

Strongly Disagree | 1 2 3 4 5 | Strongly Agree

4. It is useful for me to do lots and lots of problems when learning physics.

Strongly Disagree | 1 2 3 4 5 | Strongly Agree

5. After I study a topic in physics and feel that I understand it, I have difficulty solving problems on the same topic.

Strongly Disagree | 1 2 3 4 5 | Strongly Agree

Adams, W. K., et al (2006). New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey. *Physical Review Special Topics - Physics Education Research*, 2(1), 010101.

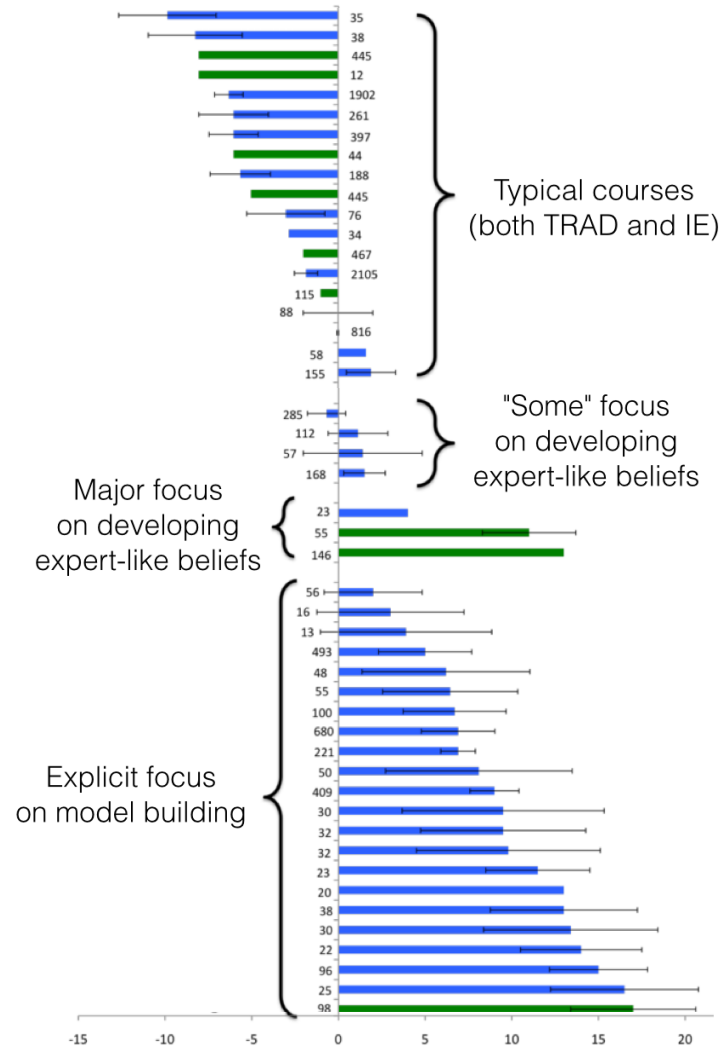


Student Beliefs

- 24 studies
- Teaching method, class size, student population

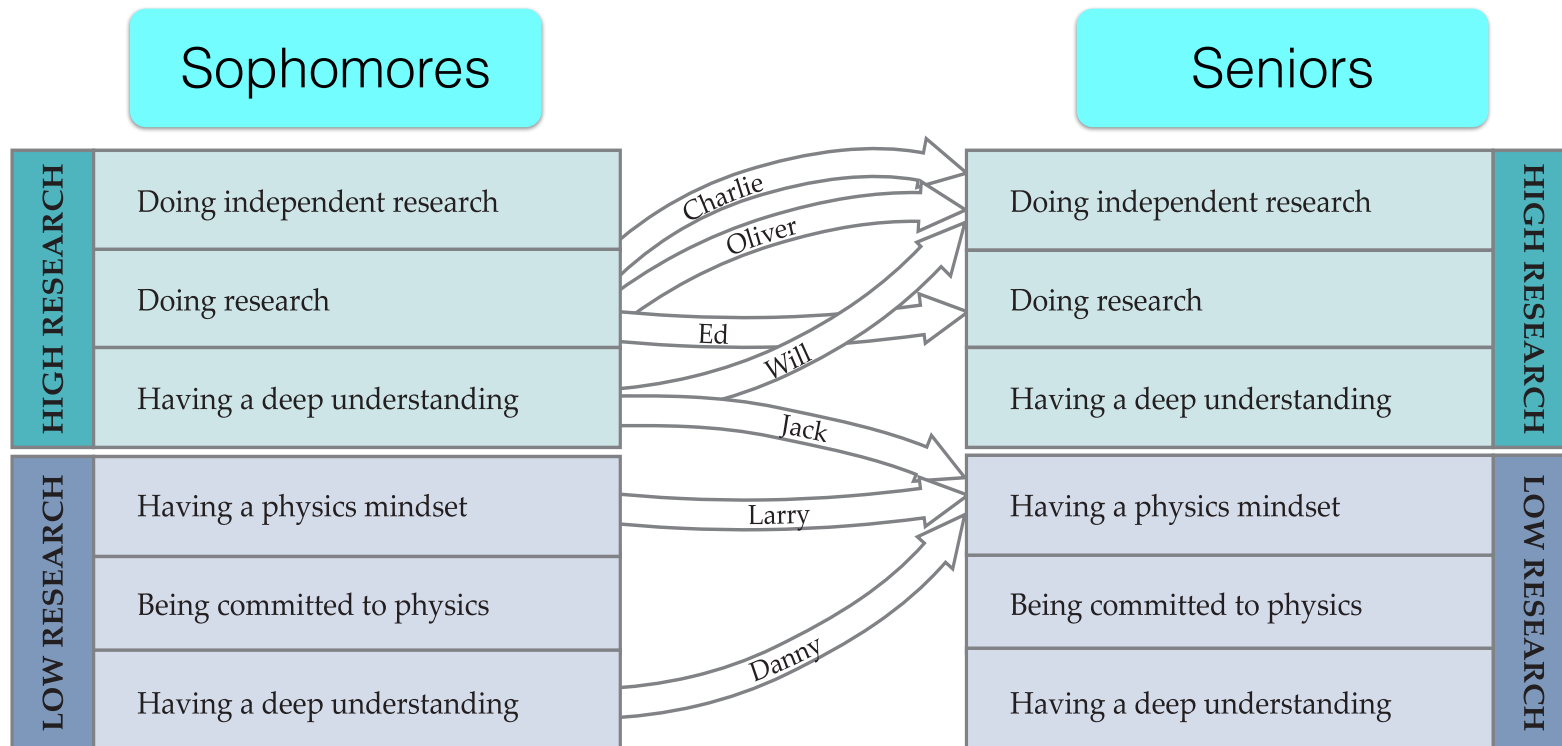
"Ordinary" IE is not enough.

Focus on connecting ideas and observations. ("model building")



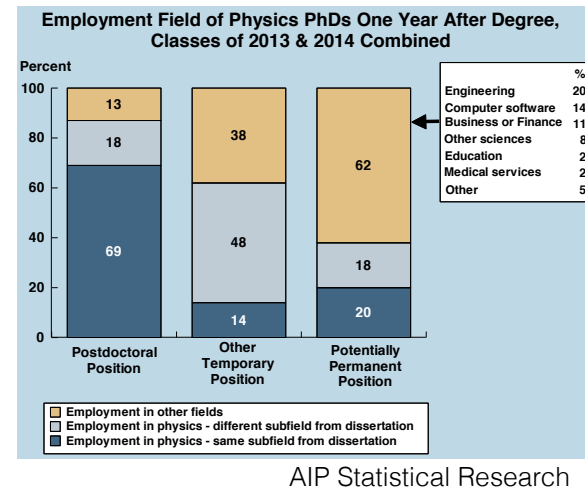
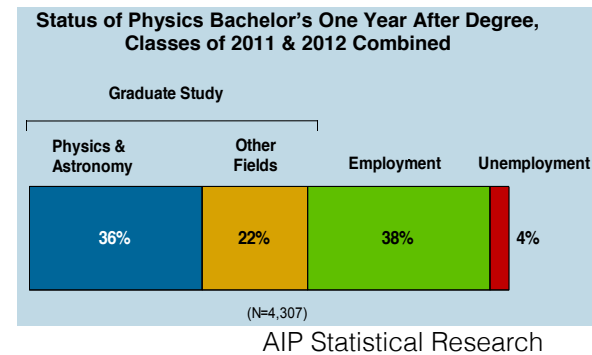
Madsen, A. M., McKagan, S. B., & Sayre, E. C. (2015). How Physics Instruction impacts students' beliefs about learning physics. *Physical Review Special Topics — Physics Education Research*.

What are physicists?



Preparing non-faculty physicists

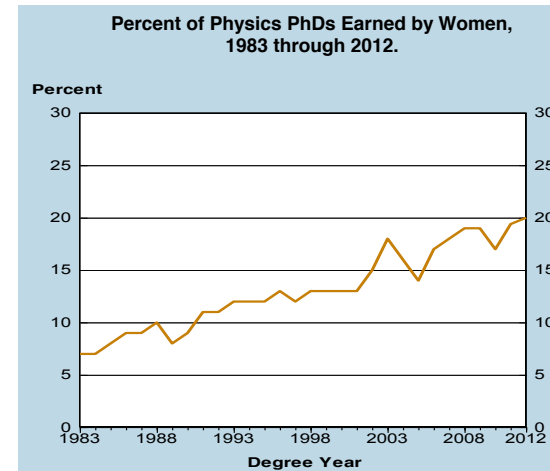
We are the 1%.



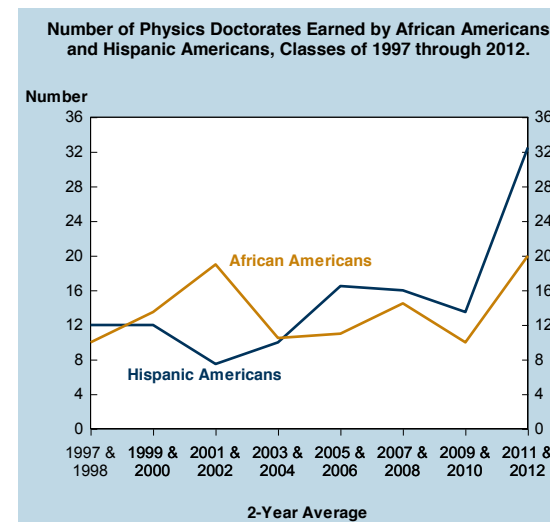
Preparing
non-faculty
physicists

We are the 1%.

Excluding
non-white,
non-cis,
non-male
physicists



AIP Statistical Research

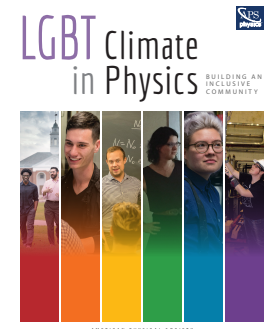
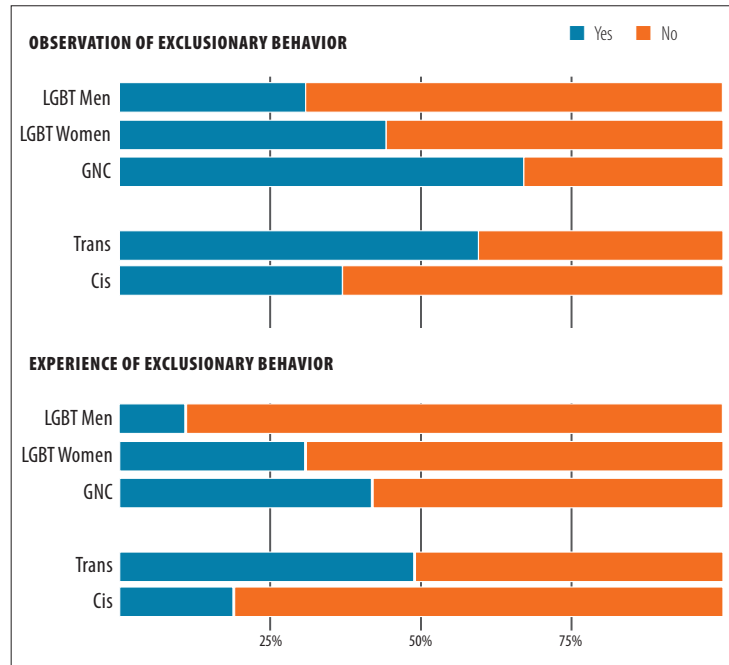


AIP Statistical Research

We are the 1%.

Preparing non-faculty physicists

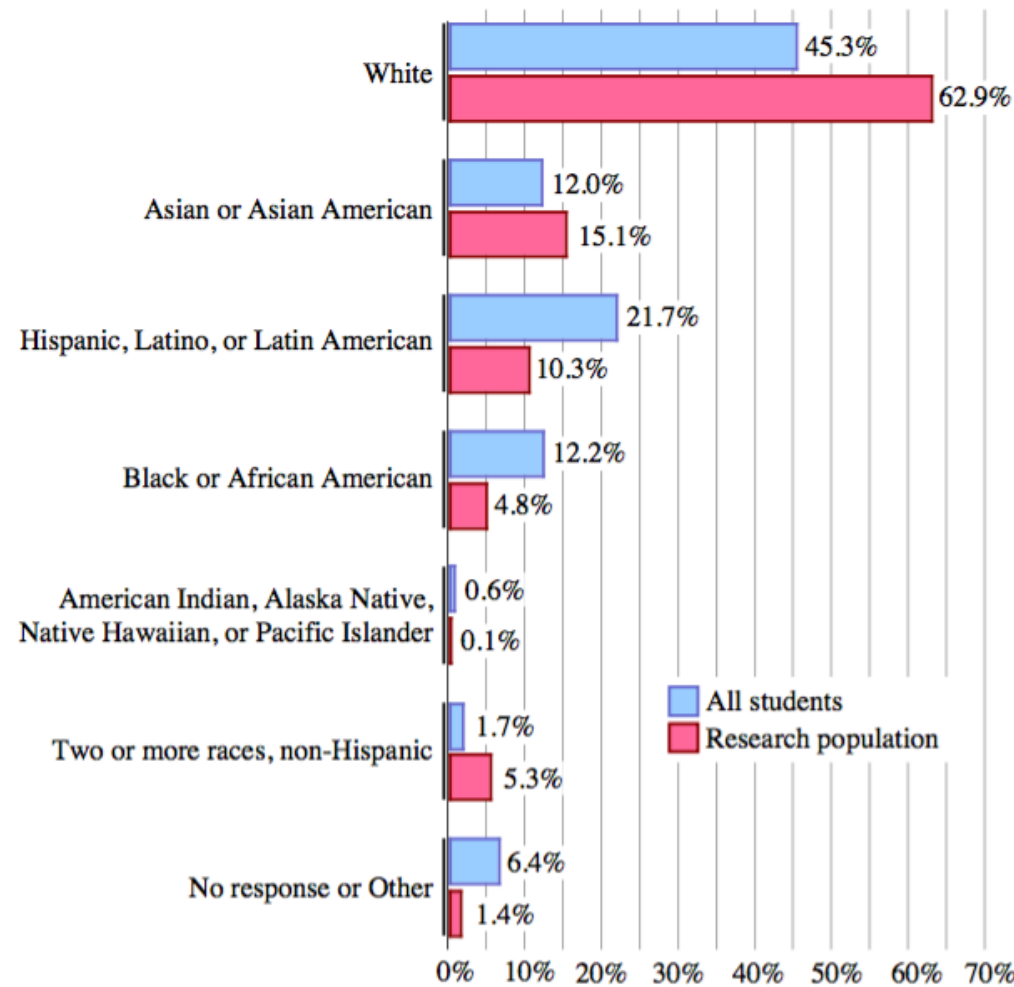
Excluding non-white, non-cis, non-male physicists



We are the 1%.

Preparing non-faculty physicists

Excluding non-white, non-cis, non-male physicists



Where are physics students?

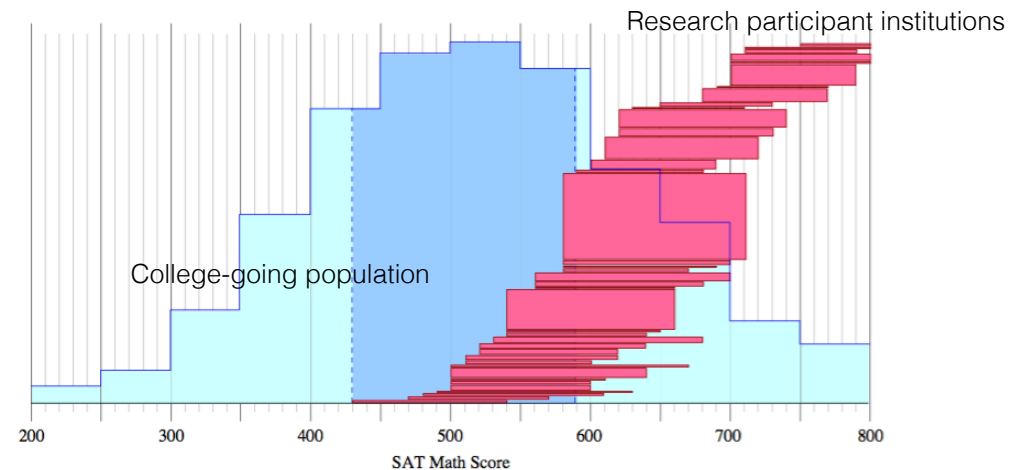
- 1/3 of all physics majors come from Bacc departments
- 2/3 of physics departments are Bacc only.

Introductory physics course enrollments at physics departments, academic year 2007-08.

Highest physics degree offered by department	Calculus Based	Algebra Based	Conceptual
Bachelor's	49,000	48,000	30,000
Master's	18,000	18,000	13,000
PhD	112,000	87,000	32,000
Total	179,000	153,000	75,000

We estimate that more than 215,000 students were enrolled in a physics or physical science course in a two-year college during the

AIP Statistical Research



Cid and Kanim, arXiv:1710.02598



Gender gaps in learning physics

Men outperform women on RBAs

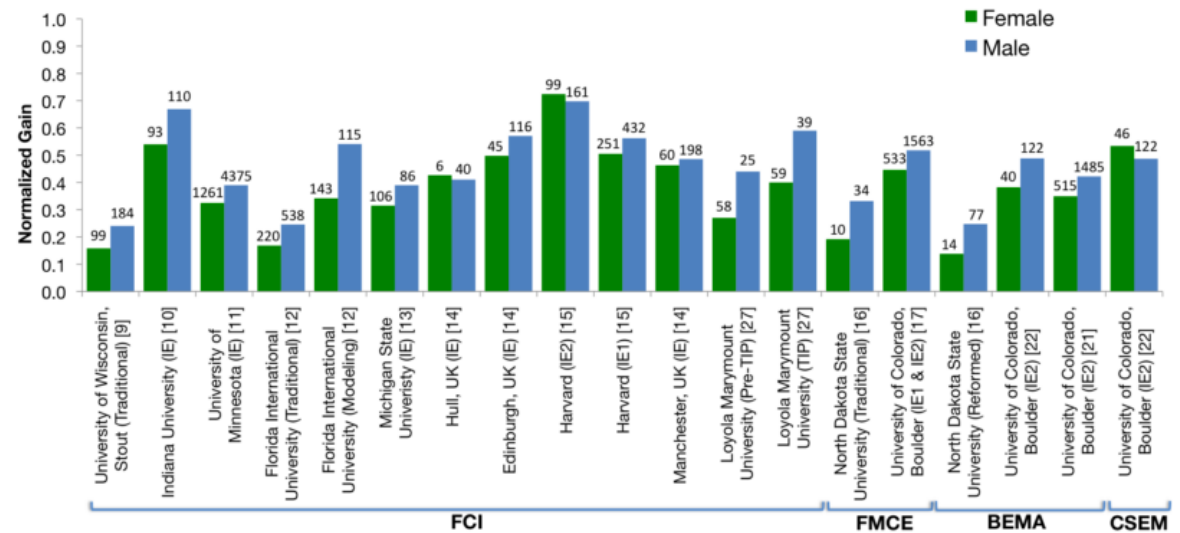
Mechanics: Men = .43; Women = .37

E&M: Men = .42; Women = .36

This is smaller than the Trad / IE gap.

There is no single factor which causes or maintains the gap.

Bias can be subtle. Need process measures.



Madsen, A., McKagan, S. B., & Sayre, E. C. (2013). Gender gap on concept inventories in physics: What is consistent, what is inconsistent, and what factors influence the gap? *Physical Review Special Topics - Physics Education Research*, 9(2), 020121.



Gender gap: causes

Type of factor	Examples	Explains part of gap?
Background and preparation	high school GPA, major, physics1 grade, years of physics	no
Other assessment	other RBAI scores, grade in class	yes
Teaching method	Level of IE, Studio physics, etc	inconclusive or no.
Sociocultural factors	stereotype threat, beliefs inventories, locus of control	often yes.
Question construction	Item analysis, everyday vs. feminine context	no



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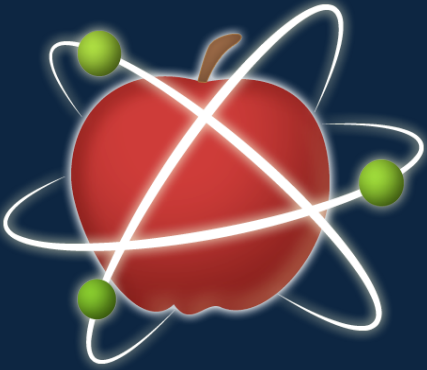
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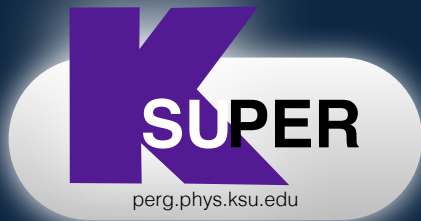




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Periscope

HANDOUT

What instructor behaviors facilitate student learning?

Introduction

In classes centered on collaborative group work, one of the instructor's most important jobs is to create an environment in which students express their physics ideas, engage with each other's reasoning, and get closer to a scientific understanding. What instructor behaviors best support these goals for students?

This episode shows an instructor in a tutorial who listens to a group of students express their ideas, then helps them clarify their different arguments. Sample discussion prompts are about what features of the interaction may have helped to make it successful.



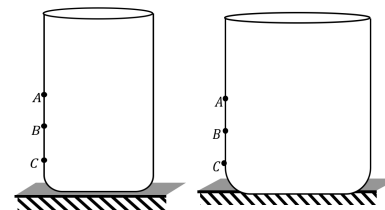
Episode: "Depth"

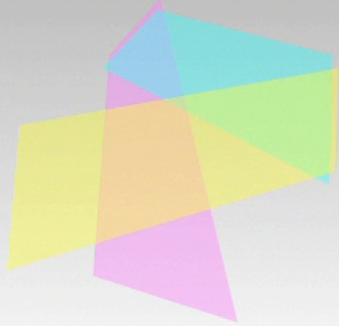
Task for students

(from Open Source Tutorials in Physics Sense-Making)

Two containers with small holes in their sides are filled to the brim.

- Using a dashed line, sketch the path you think the water from each hole will take when it leaves the container.
- Where do you think the water will squirt out the hardest, and where the most weakly (or will it be equal)?
- What causes the water to squirt out more strongly from some places than from others? Explain the idea that you think should guide your predictions from now on.





Periscope

Looking into learning

in best-practices physics classrooms

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Episode 101: “Depth”

*Filmed at the University of Maryland
using Open Source Tutorials*



Supported in part by
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What instructor behaviors facilitate student learning?

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- What do you notice? Talk with the people near you.
- What does Levi do to draw out students' ideas?

Sample discussion prompts

1. **What did you notice** in this episode? Talk to your neighbor about what you noticed.
2. The first step in effectively facilitating student learning is to find out where the students are coming from. What does Levi (the instructor) **say** that gets his students to articulate their ideas?
3. What does Levi **do (nonverbally)** to support the students in expressing themselves?
4. It can be tricky for an instructor to **draw out both sides of a contradictory argument without embarrassing anyone**. What specific strategies or behaviors does Levi use to keep everyone in the game?
5. **What instructor behaviors facilitate student learning**, as suggested in

Transcript

Available now!

66 lessons
Facilitators' Guide





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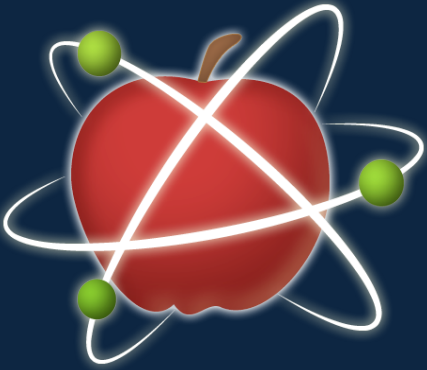
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