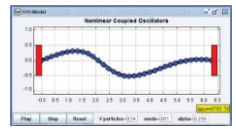
Research-based Resources PhysPort & ComPADRE

Bruce Mason,
Eleanor C Sayre,
Sam McKagan,
Adrian M Madsen

ComPADRE: Platform, Services, Resources

PhysPort — Supporting physics teaching with research-based resources — Research-Based Resources

O•S•P open source physics



Open Source Physics

Adopt: Outreach

per central — Education research is our focus — PER Community

the Quantum exchange

Quantum

The Physics Source for Introductory Physics Courses

Intro Undergrad Resources

STP

IPLS Life Sciences

SUPC Upper Division

AAPT Physics Education Advanced Labs

Advanced Labs

PICUP

Computational Physics

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PhysPort

Supporting physics teaching with research-based resources

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

www.physport.org

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PhysPort Team

American Association of Physics Teachers




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

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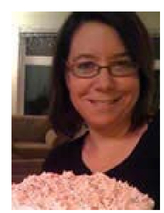
Josh Weese (*development lead*)

Theresa Neil Design

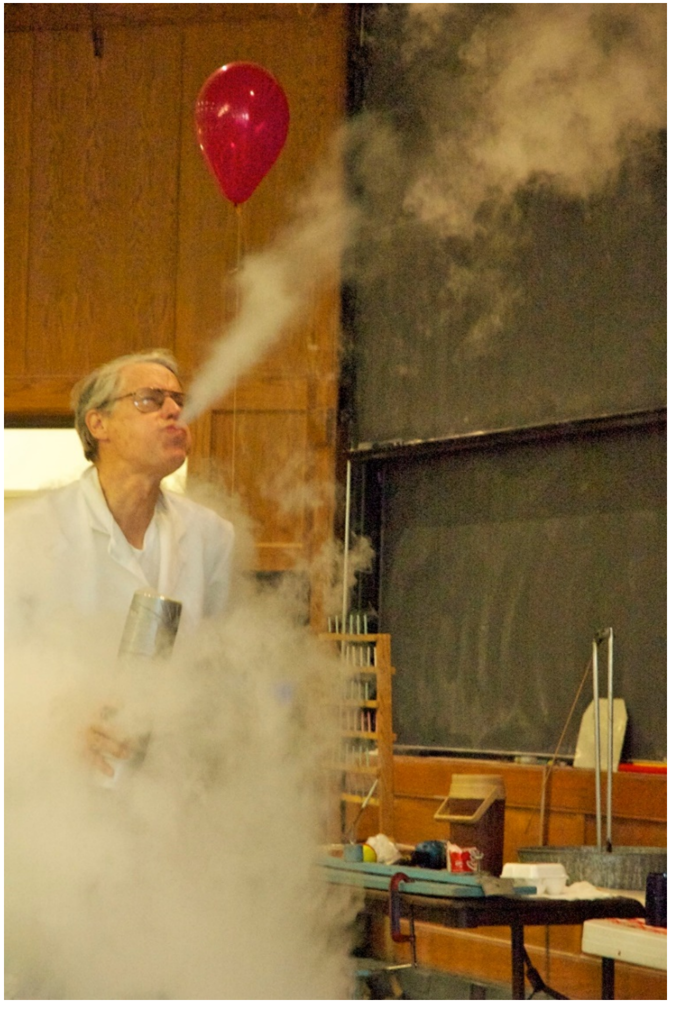
Sandy Martinuk
(*User Experience*)

Periscope Specialists




Rachel Scherr
Stephanie Chasteen

"Teach like a Scientist"



(Not This)

A) What does this mean?

B) What will you do?

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What are you curious about?

Faculty have big questions.

How to compare teaching methods?

What are my students learning?

What materials are available?

What are communities creating?

How do I prepare TAs?

How do I support diverse learners?

What works best for my context?

course

program

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PhysPort can help.

NFW is overwhelming.

Finding information and advice

Changing teaching practices

Supporting physics teaching with research-based resources

Faculty-centered online resources

Synthesis research

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Conference Proceedings

Community Collections and Development

ComPADRE can help.

Free and Open Resources

Vetted Library of Teaching and Support Resources

Search
Browse
Collect
Share

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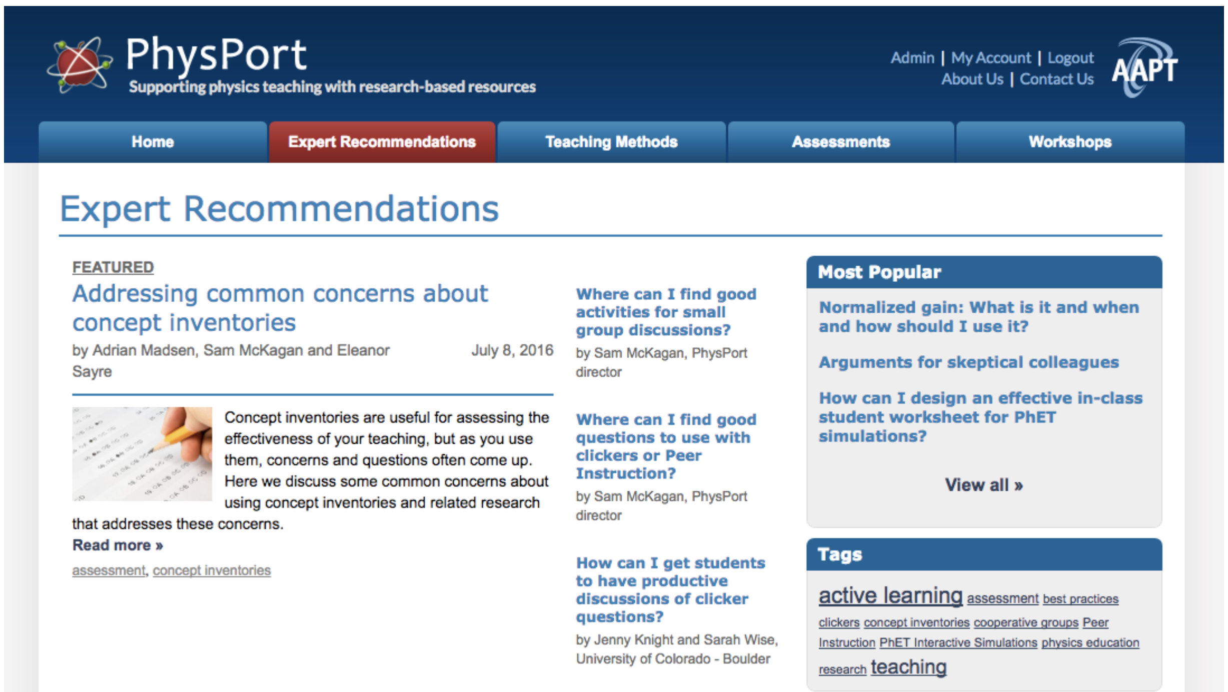
Expert Recommendations

physport.org/recommendations

What should I do about …. ?

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



Real questions.

Research-based answers.

Faculty-centered resources.

Have a suggestion?

Want to contribute?

esayre@ksu.edu

smckagan@aapt.org

Teaching Methods

physport.org/methods/

How do I know which way to teach?

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

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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

Force Concept Inventory

Typical results

RESEARCH VALIDATION SUMMARY

Based on Research Into:

- ✅ **Student thinking**

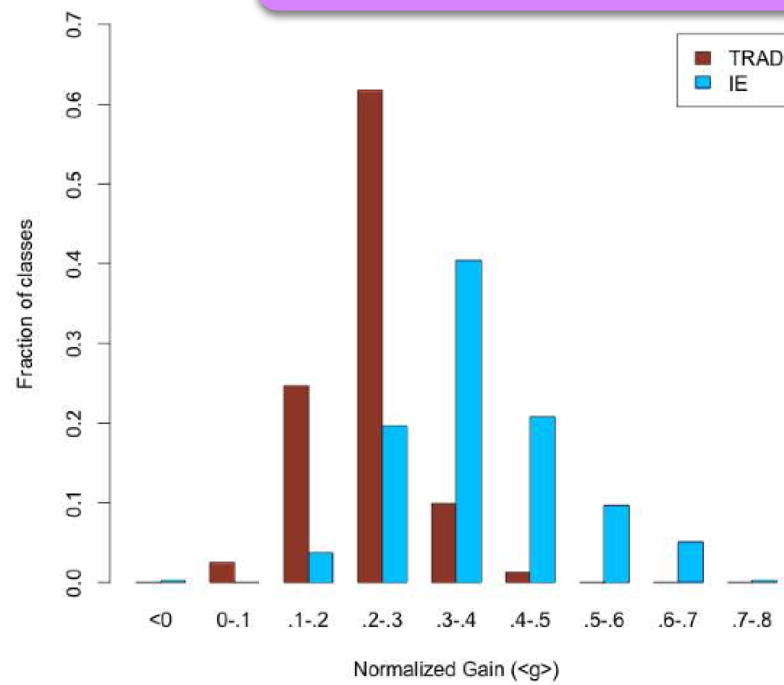
Studied Using:

- ✅ **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 level at over 70 institutions and including data on over 35,000 students. Most notable is the study by Hake (1998) comparing FCI scores based on instructional method for over 6500 students.



Research summary

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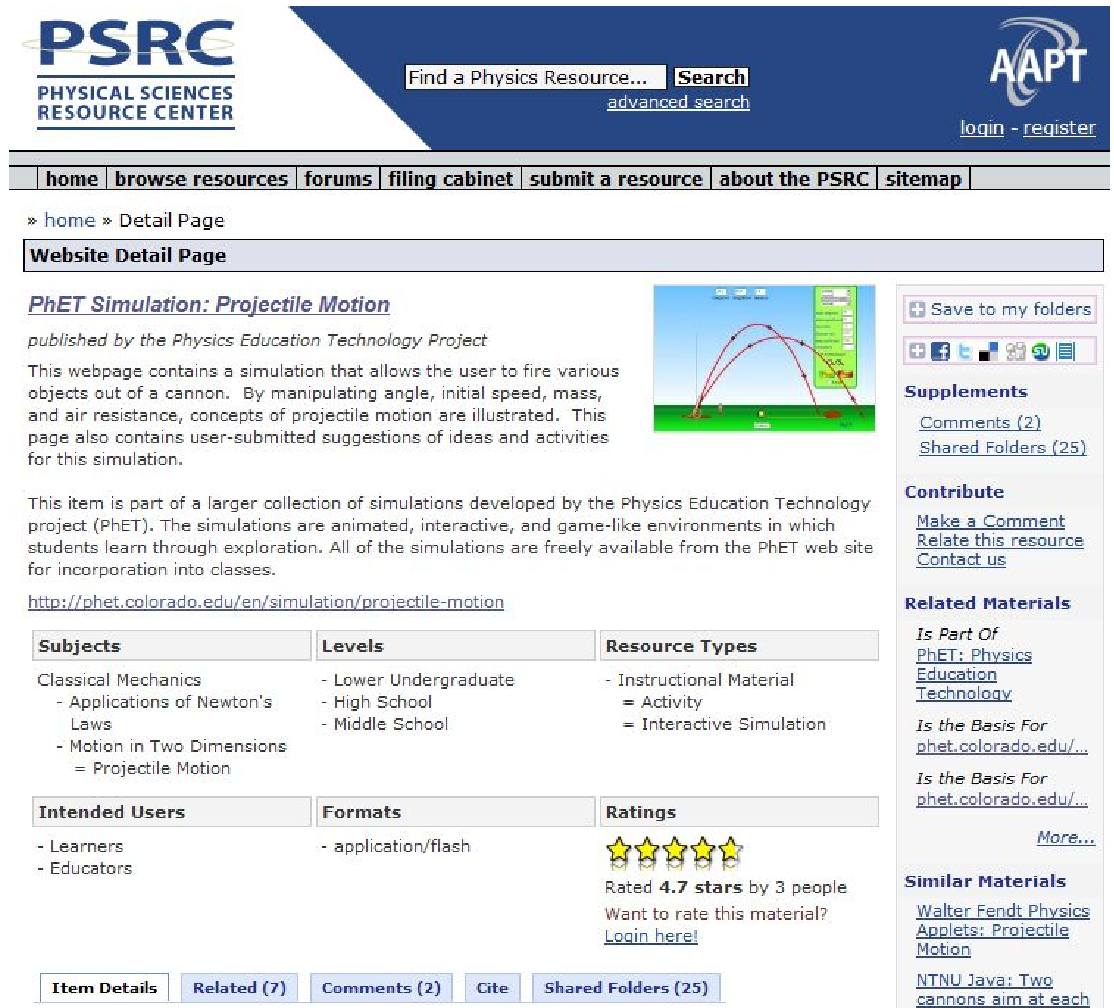
ComPADRE Library

compadre.org/portal/search/advanced.cfm

Where can I find things to use in my class?

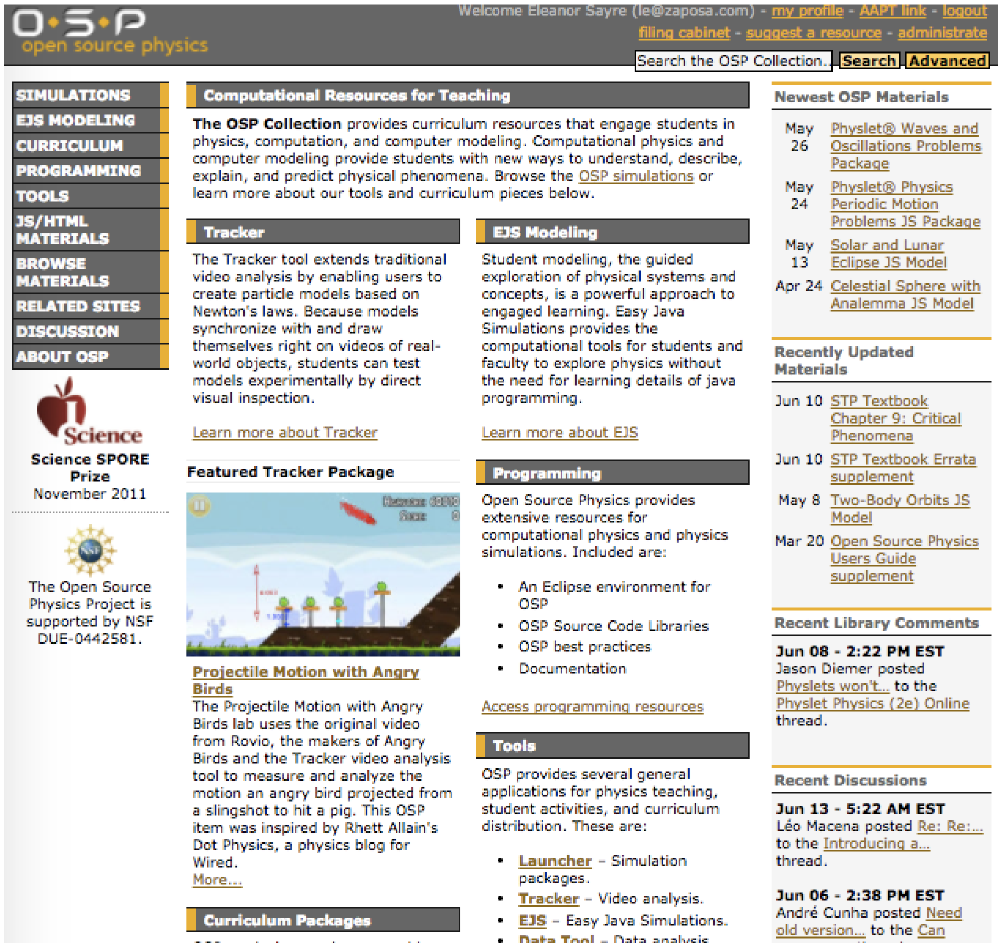
- Search
- Browse
- Vetted
- Sharing
- Details
- Faculty-Focus



Open Source Physics

www.compadre.org/osp/

What are some special Collections?



O·S·P open source physics

Welcome Eleanor Sayre (le@zaposa.com) - my profile - AAPT link - logout
filing cabinet - suggest a resource - administrate

Search the OSP Collection. | Search | Advanced

- SIMULATIONS
- EJS MODELING
- CURRICULUM
- PROGRAMMING
- TOOLS
- JS/HTML MATERIALS
- BROWSE MATERIALS
- RELATED SITES
- DISCUSSION
- ABOUT OSP

Science

Science SPORE Prize
November 2011

The Open Source Physics Project is supported by NSF DUE-0442581.

Computational Resources for Teaching

The OSP Collection provides curriculum resources that engage students in physics, computation, and computer modeling. Computational physics and computer modeling provide students with new ways to understand, describe, explain, and predict physical phenomena. Browse the OSP simulations or learn more about our tools and curriculum pieces below.

Tracker

The Tracker tool extends traditional video analysis by enabling users to create particle models based on Newton's laws. Because models synchronize with and draw themselves right on videos of real-world objects, students can test models experimentally by direct visual inspection.

Learn more about Tracker

EJS Modeling

Student modeling, the guided exploration of physical systems and concepts, is a powerful approach to engaged learning. Easy Java Simulations provides the computational tools for students and faculty to explore physics without the need for learning details of java programming.

Learn more about EJS

Featured Tracker Package

Projectile Motion with Angry Birds

The Projectile Motion with Angry Birds lab uses the original video from Rovio, the makers of Angry Birds and the Tracker video analysis tool to measure and analyze the motion an angry bird projected from a slingshot to hit a pig. This OSP item was inspired by Rhett Allain's Dot Physics, a physics blog for Wired.
More...

Curriculum Packages

Programming

Open Source Physics provides extensive resources for computational physics and physics simulations. Included are:

- An Eclipse environment for OSP
- OSP Source Code Libraries
- OSP best practices
- Documentation

Access programming resources

Tools

OSP provides several general applications for physics teaching, student activities, and curriculum distribution. These are:

- **Launcher** – Simulation packages.
- **Tracker** – Video analysis.
- **EJS** – Easy Java Simulations.
- **Data Tool** – Data analysis

Newest OSP Materials

- May 26 Physlet® Waves and Oscillations Problems 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

- 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

Recent Library Comments

Jun 08 - 2:22 PM EST
Jason Diemer posted Physlets won't... to the Physlet Physics (2e) Online thread.

Recent Discussions

Jun 13 - 5:22 AM EST
Léo Macena posted Re: Re:... to the Introducing a... thread.

Jun 06 - 2:38 PM EST
André Cunha posted Need old version... to the Can

As Seen on Tuesday

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Questions so far?

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What do you want to do now?

A. I would like to explore the PhysPort Teaching Methods and Expert Recommendations help

B. I want to find out more about the many available Learning Assessments and how I might use them

C. I want to explore ComPADRE Community Resource Collections for Computation, OSP, and Advanced Labs

D. I want to look through vetted examples of ComPADRE content on different topics and levels

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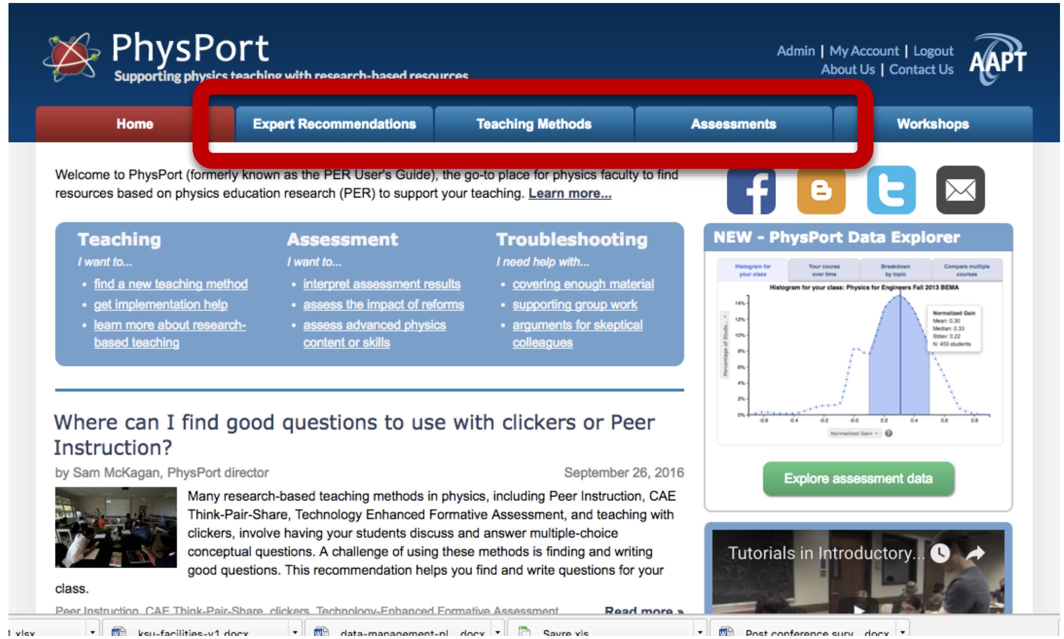
For A & B:

physport.org



For C:

compadre.org/osp — Open Source Physics

compadre.org/advlabs — Advanced Labs

compadre.org/picup — Computation in UG Phys

For D:

compadre.org/books/nfwdl

Online workshops: Periscope & NFW

physport.org/workshops

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

Virtual New Faculty Workshop

What is the Virtual New Faculty Workshop?

Videos of presentations from the live Workshop for New Faculty in Physics and Astronomy feature:

- leaders in physics education research and curriculum development
- teaching techniques proven to work in many environments
- cutting-edge developments in physics/astronomy curriculum and pedagogy

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

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Periscope

physport.org/periscope

Videos of students working. 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?

Modeling Instruction, mechanics, forces, friction, Florida International University

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

Episode 502: "Moving box"

FIU

0:00 / 2:39

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 … facilitates … discussion …

Open handout in new window

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?

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.

Episode: "Moving box"

Task for students *(from University Modeling Instruction)*

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

Sample discussion prompts

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

Available now!

66 lessons

Facilitators' Guide

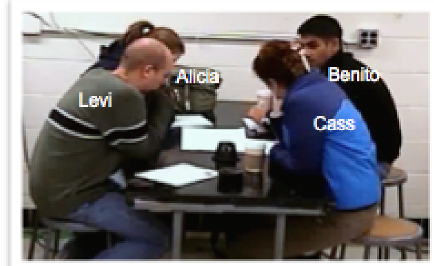
Bruce Mason, bmason@ou.edu

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

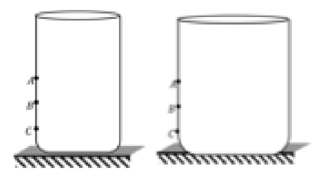
(from Open Source Tutorials in Physics Sense-Making)

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

A. Using a dashed line, sketch the path you think the water from each hole will take when it leaves the container.

B. Where do you think the water will squirt out the hardest, and where the most weakly (or will it be equal)?

C. 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.



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 this episode?

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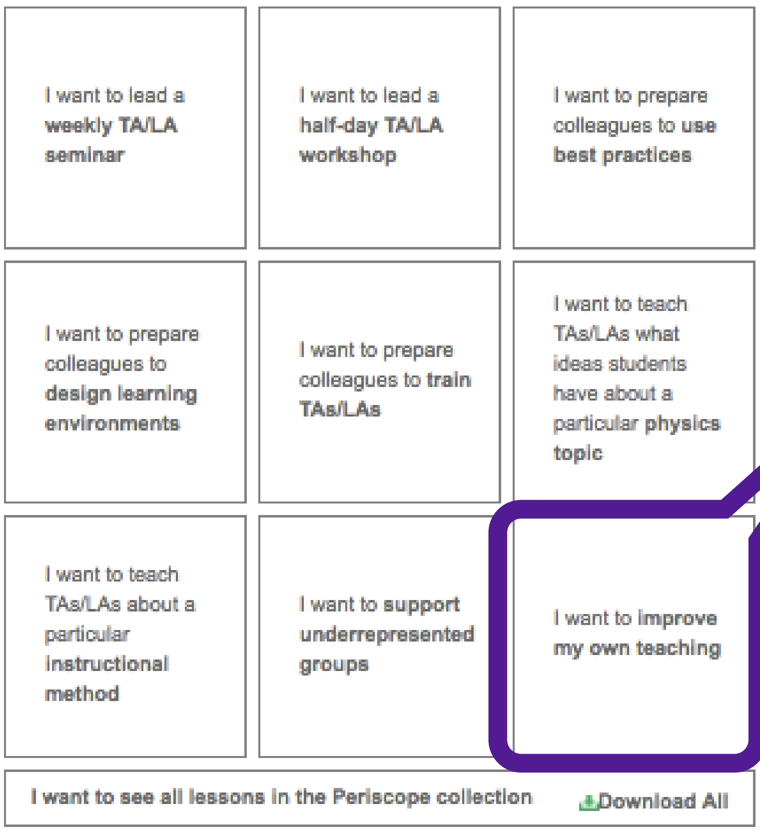
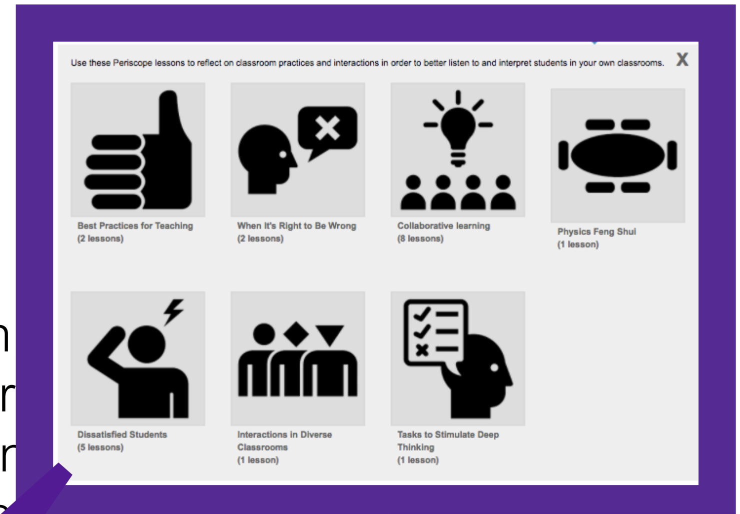
Periscope

physport.org/periscope

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





Available now!

66 lessons

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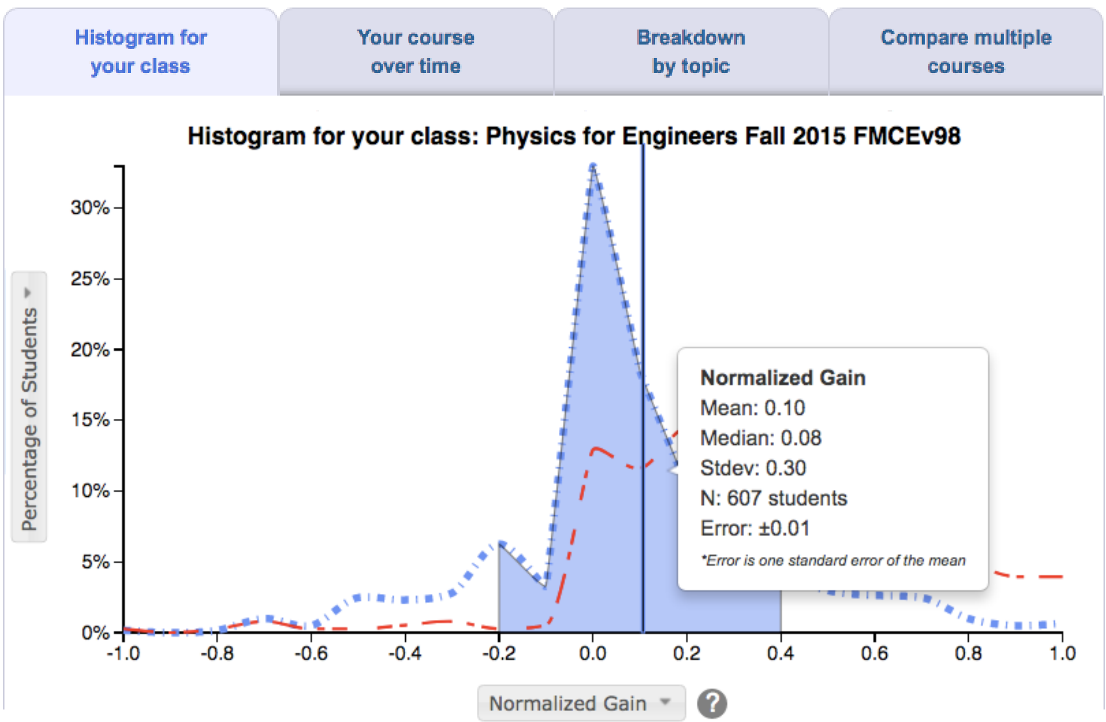
Data Explorer

physport.org/DataExplorer

Data Analysis: So you don't have to!

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



Upload your data

Explore your data

Download a report

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Data Explorer

physport.org/DataExplorer

Summary

Average Gain ? **0.10** ± 0.01	Your students' average normalized gain of **0.10 ± 0.01** is near the bottom of the range for traditional lecture classes . See typical results.
Effect Size ? **0.61**	The effect size of the change between pre and post for your class is **0.61**. This is a moderate effect size
Average Score ? **Pre 18%** ± 1% **Post 30%** ± 1%	Your students' average score increased from **18% ± 1%** on the pre-test to **30% ± 1%** on the post-test. See typical results.
N (matched) **607**	You have 607 "matched" students (who took both the pre- and post-test) in your class. All calculations are based on matched students.

Recommendations

Courses that are taught using interactive engagement techniques tend to have higher normalized gains than those using traditional lecture. The key to these methods is getting students actively engaged in constructing their own understanding and not just passively listening.
This can be accomplished in many ways. Popular methods that you could try include: Peer Instruction, PhET Interactive Simulations, Interactive Lecture Demonstrations, and Just In Time Teaching.
As we collect more data on how teaching practices correlate with learning gains, we will eventually provide more customized recommendations.

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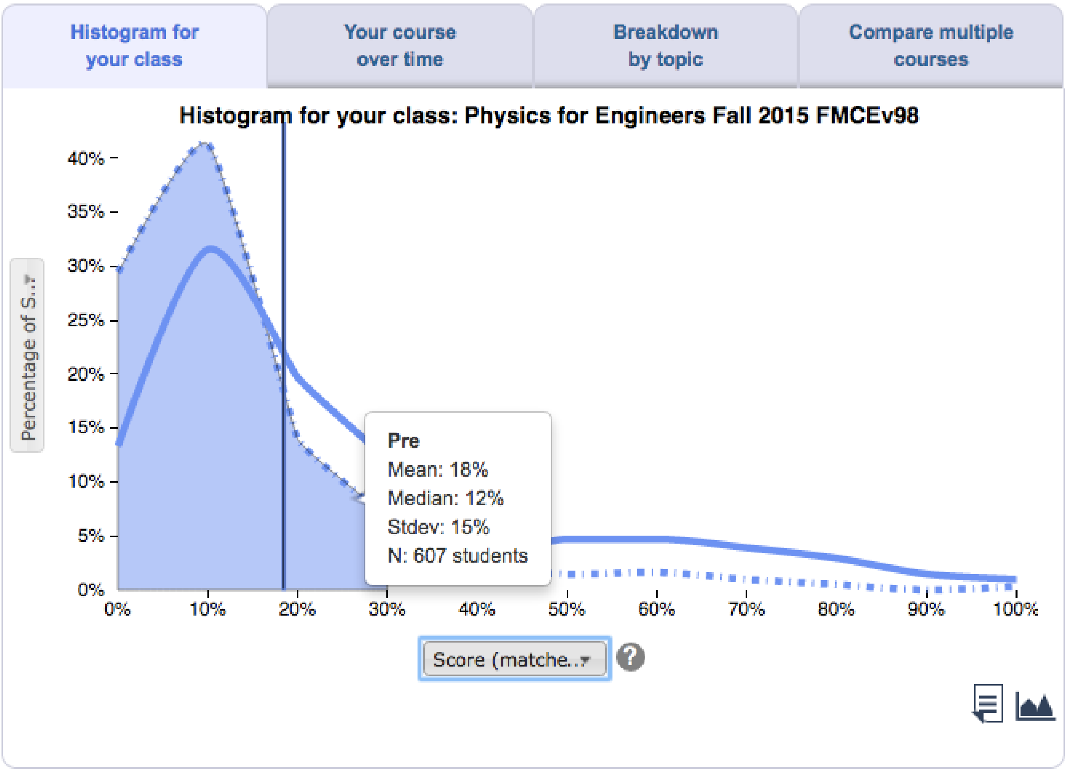

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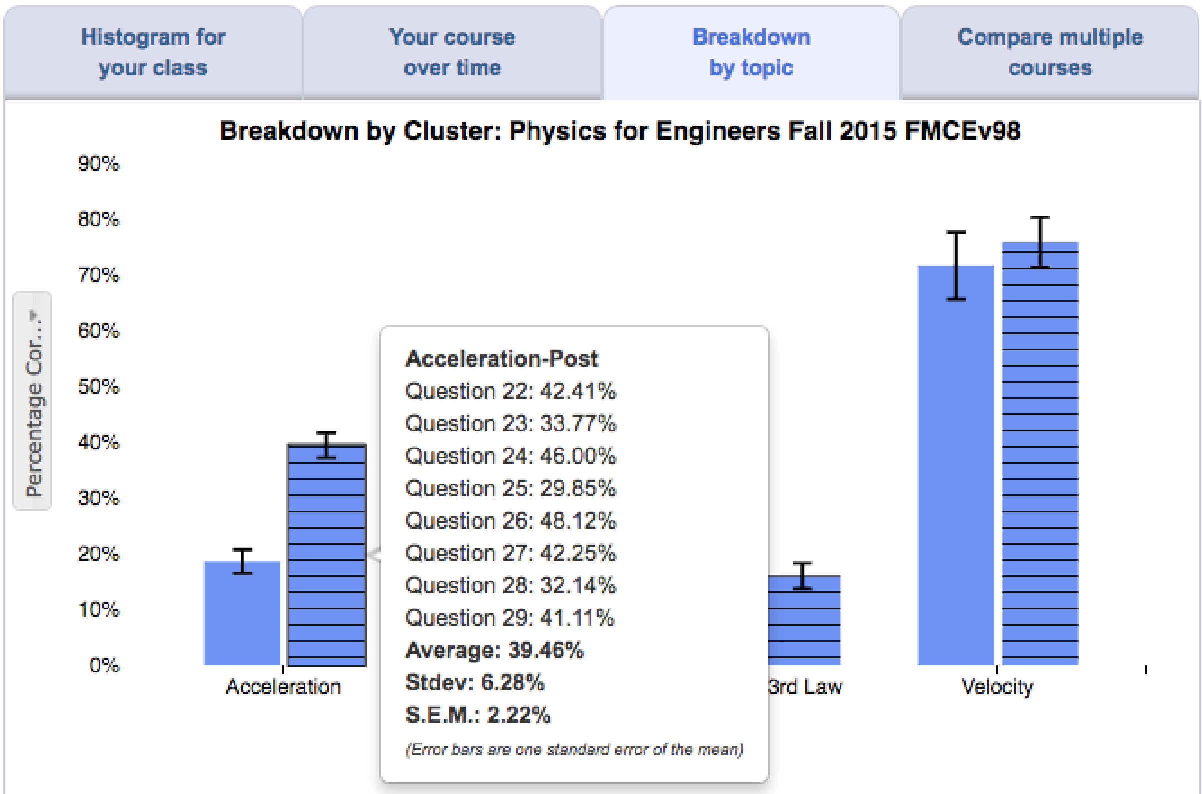

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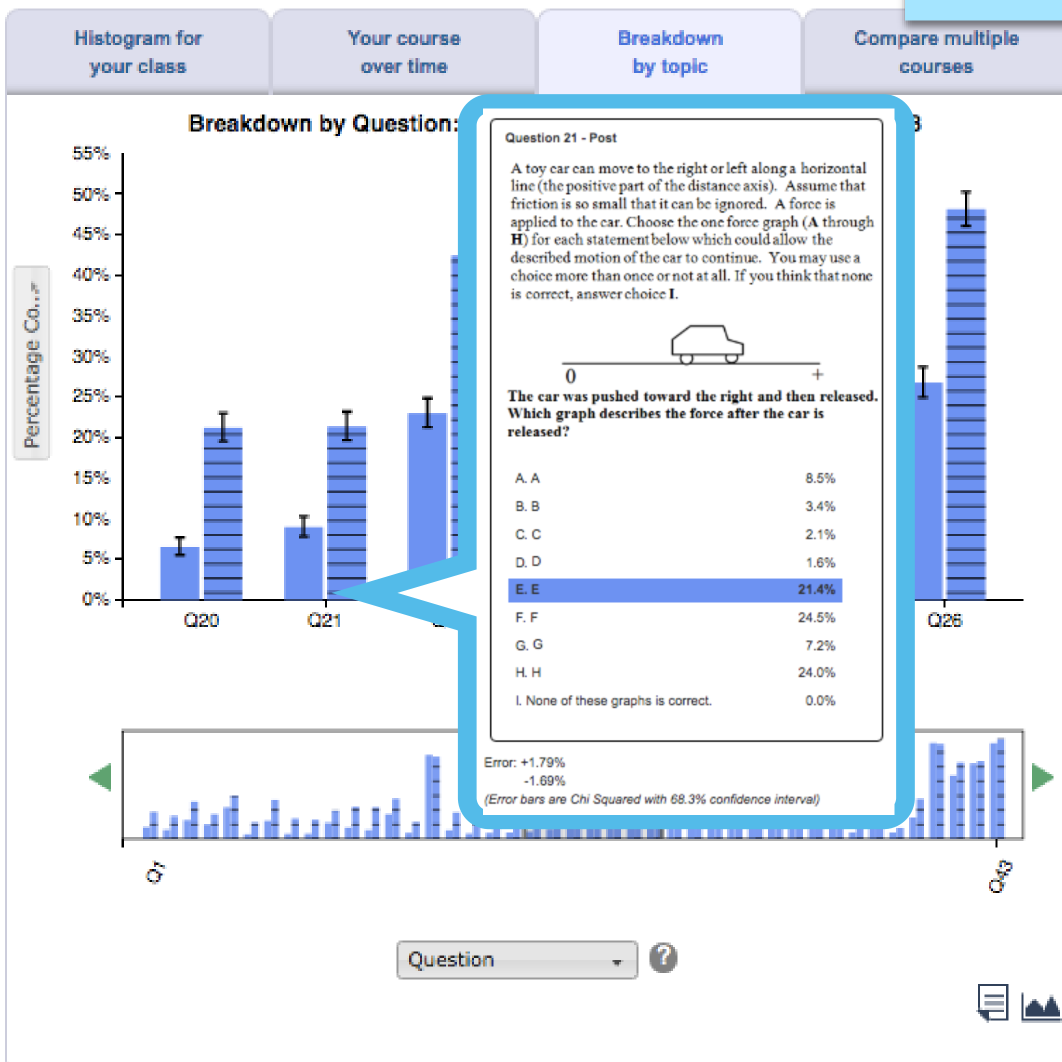

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Data Explorer

- Compare multiple courses
- Track your courses over time
- Group and split by gender, major, section, instructor, etc
- Easy upload, automatic pre/post matching and scoring
- Download pdf reports for your tenure file
- Compare to national averages
- Coming soon: Add custom assessments

physport.org/DataExplorer

Available now!

FCI, FMCE
CSEM, BEMA
CLASS, MPEX

Available soon!

80+
research-based
assessments

Custom assessments for researchers and departments

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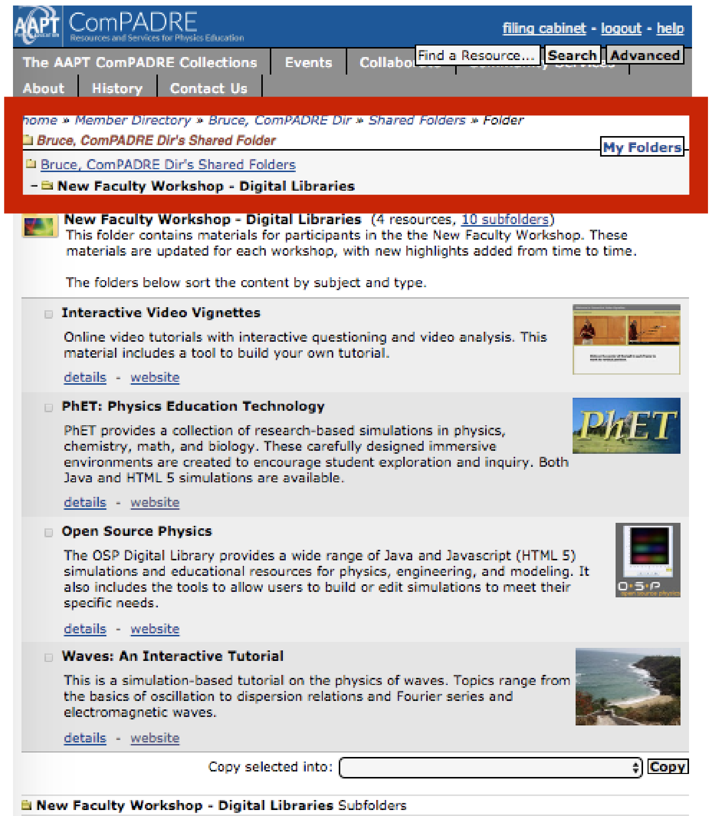
Filing cabinet

bit.ly/compadre-nfw



- NFW collection
- Join ComPADRE & Make your own collections!

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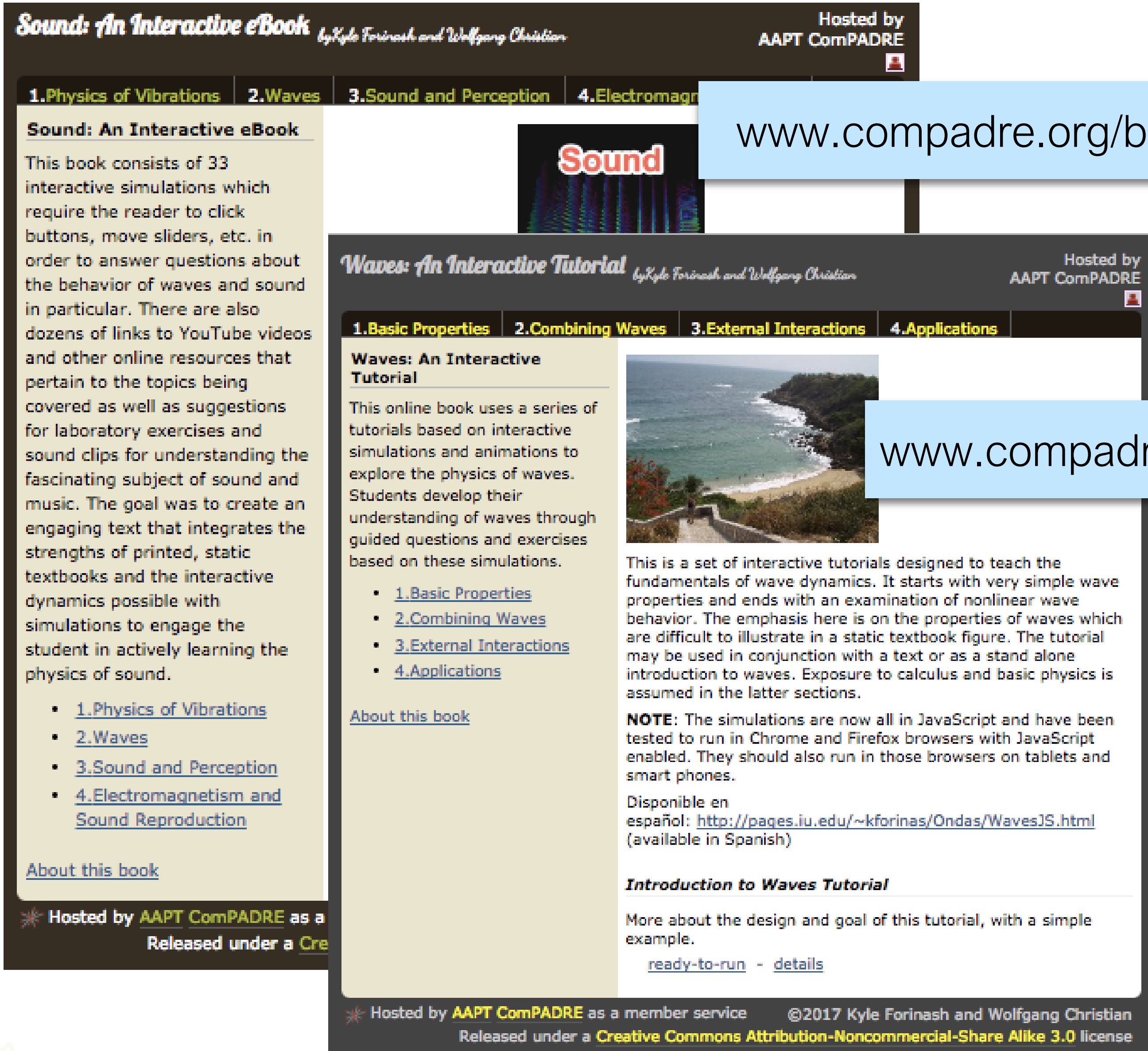
Interactive eBooks



www.compadre.org/books/SoundBook

www.compadre.org/books/wavesinttut

Data

Interpret the results of diverse PER studies

Weighted combination of published studies

More robust than single study

Vulnerable to publishing bias

Synthesis research

100,000 students

Madsen, McKagan, & Sayre (2013). Gender gap on concept inventories in physics: What is consistent, what is inconsistent, and what factors influence the gap? ***PhysRevST-PER***

Madsen, McKagan, & Sayre (2015). How Physics Instruction impacts students' beliefs about learning physics. ***PhysRevST-PER***

Von Korff, ***et al*** (in press). Secondary Analysis of Teaching Methods in Introductory Physics : a 50k - Student Study. ***AmJPhys***

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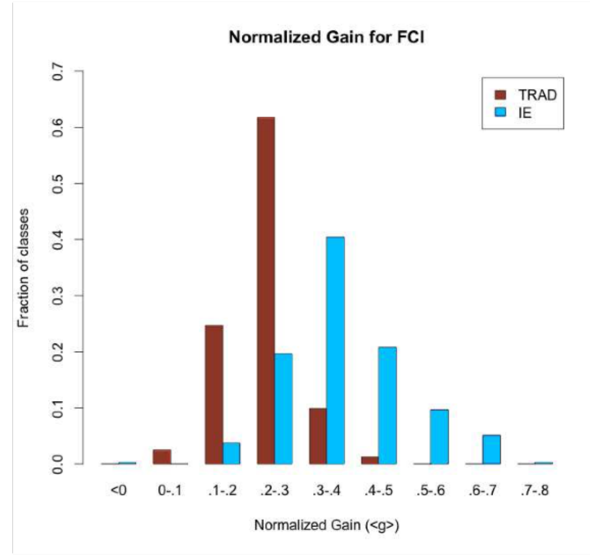
Mechanics teaching

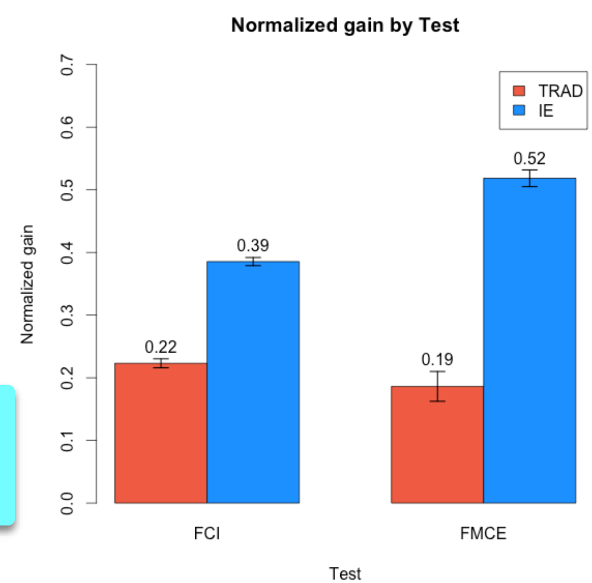
active learning
students do stuff
many different ways

Interactive engagement is better than traditional lecture

chalk-and-talk
sage on the stage
cookbook labs

50,000 Students





PhysPort.org
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AAPT comPADRE
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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.

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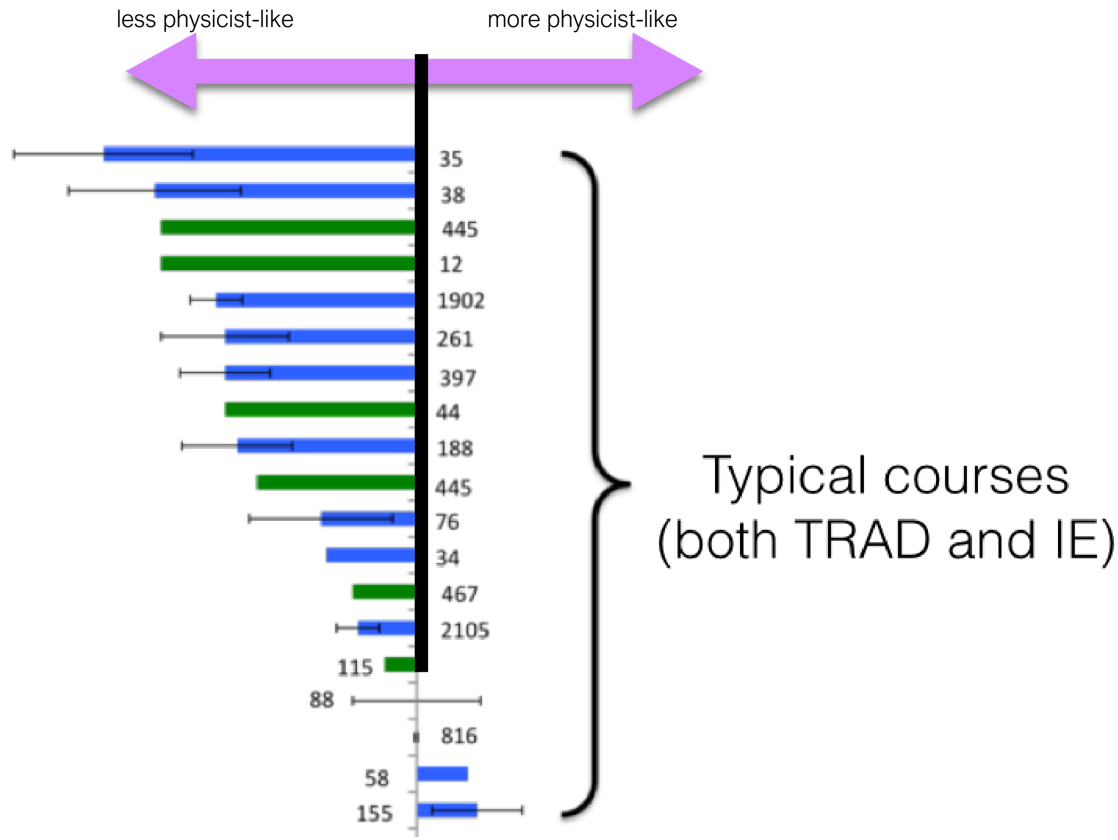
Student Beliefs

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

"Ordinary" IE
is not enough.



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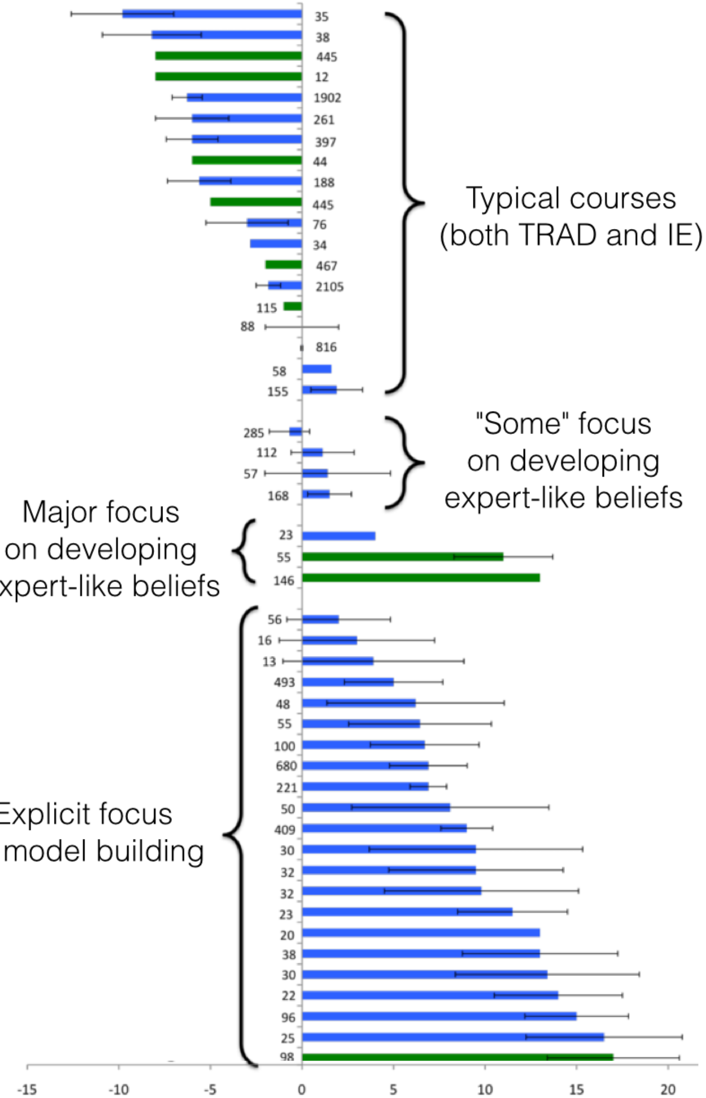
Student Beliefs

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

"Ordinary" IE is not enough.

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



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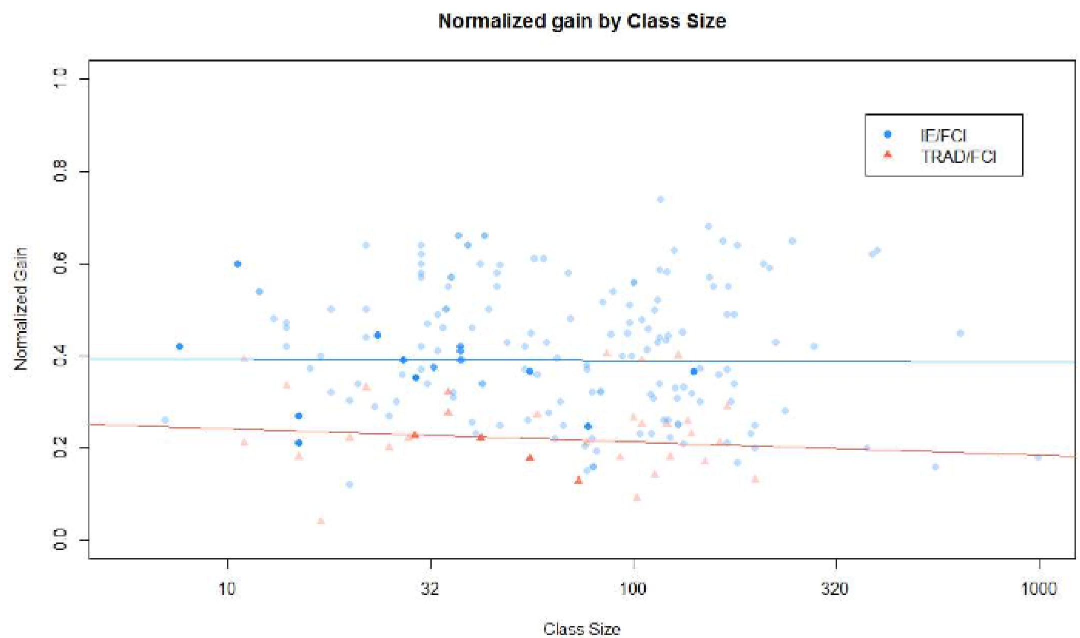
Does class size matter?

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

no.



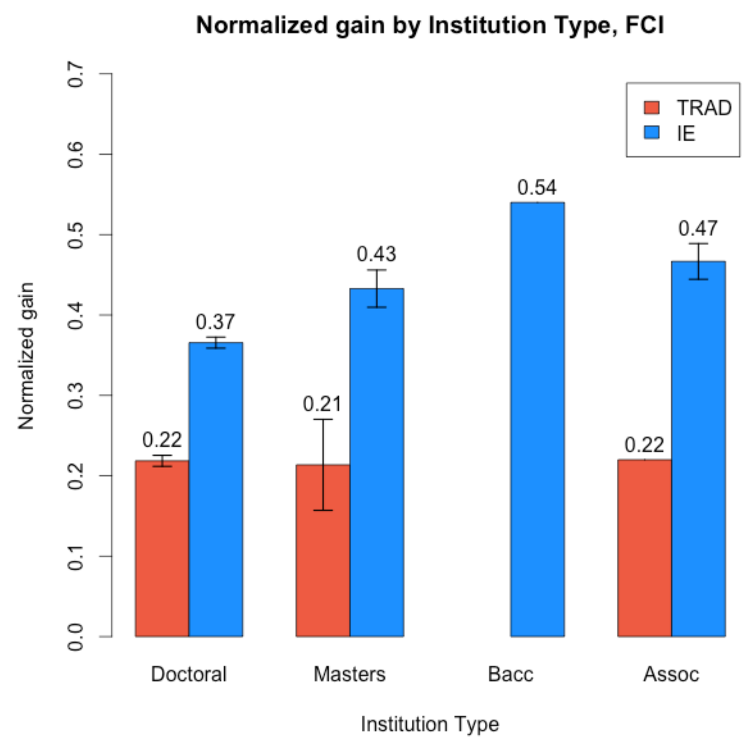
Von Korff, J., ***et al*** (2016). Secondary Analysis of Teaching Methods in Introductory Physics : a 50k - Student Study. American Journal of Physics

Does institution type matter?

- Reduced Carnegie classification
- Only US schools

no.

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



Von Korff, J., *et al* (2016). Secondary Analysis of Teaching Methods in Introductory Physics : a 50k - Student Study. American Journal of Physics

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Gender gaps in learning physics

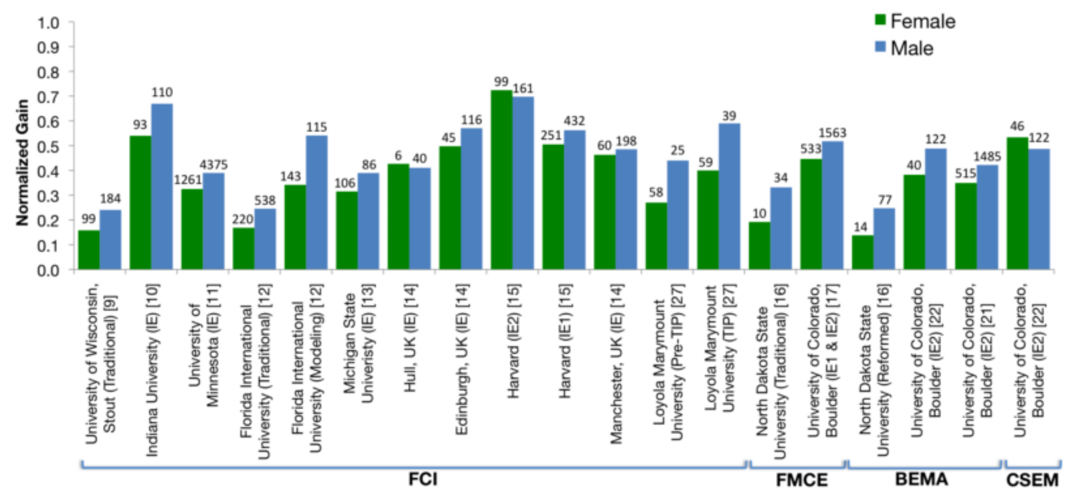
Men outperform women on RBAs

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.



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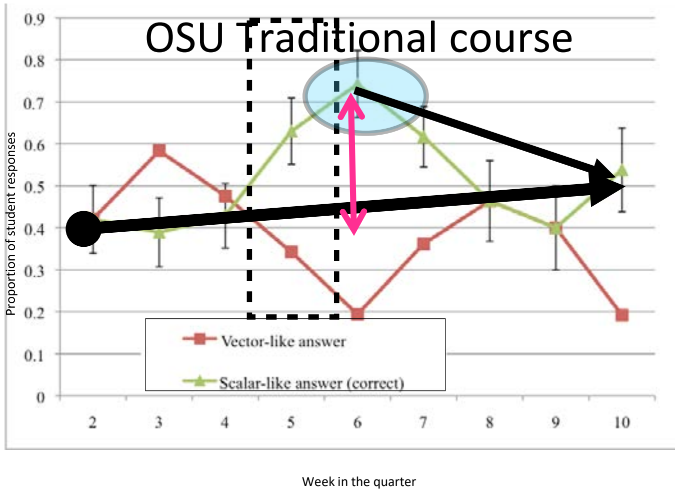
Gender gap: causes

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

Different teaching methods



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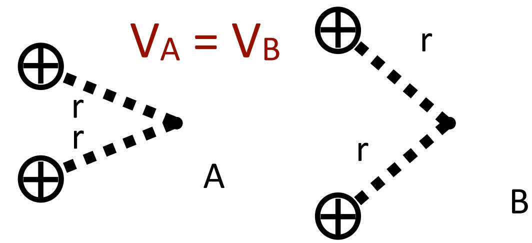
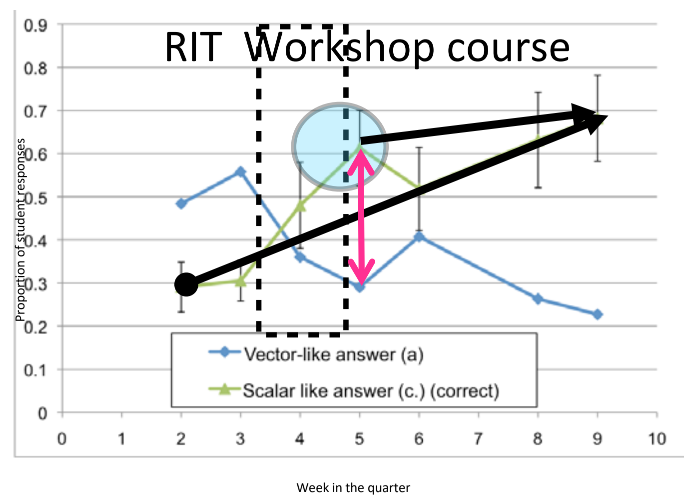


At which point is the Electric Potential greater?



<g> = 0.5

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

Traditional classes are traditionally disappointing.

Franklin, S.V., Sayre, E.C., and J. Clark (2015) "Traditionally taught students learn; actively-engaged students remember" *AJP*

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