

Research-based Resources PhysPort & ComPADRE

Bruce Mason,
Eleanor C Sayre,
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ComPADRE: Platform, Services, Resources



[Research-Based Resources](#)



[Open Source Physics](#)



[Adopt: Outreach](#)



[PER Community](#)



[Quantum](#)



[Intro Undergrad Resources](#)



[STP](#)



[Life Sciences](#)



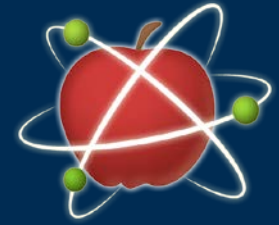
[Upper Division](#)



[Advanced Labs](#)



[Computational Physics](#)



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

PhysPort Team



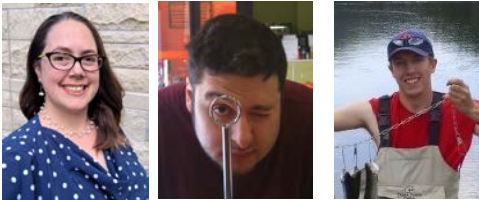
American Association of Physics Teachers



Sam McKagan (*Director*)
Adrian Madsen (*Assistant Director*)
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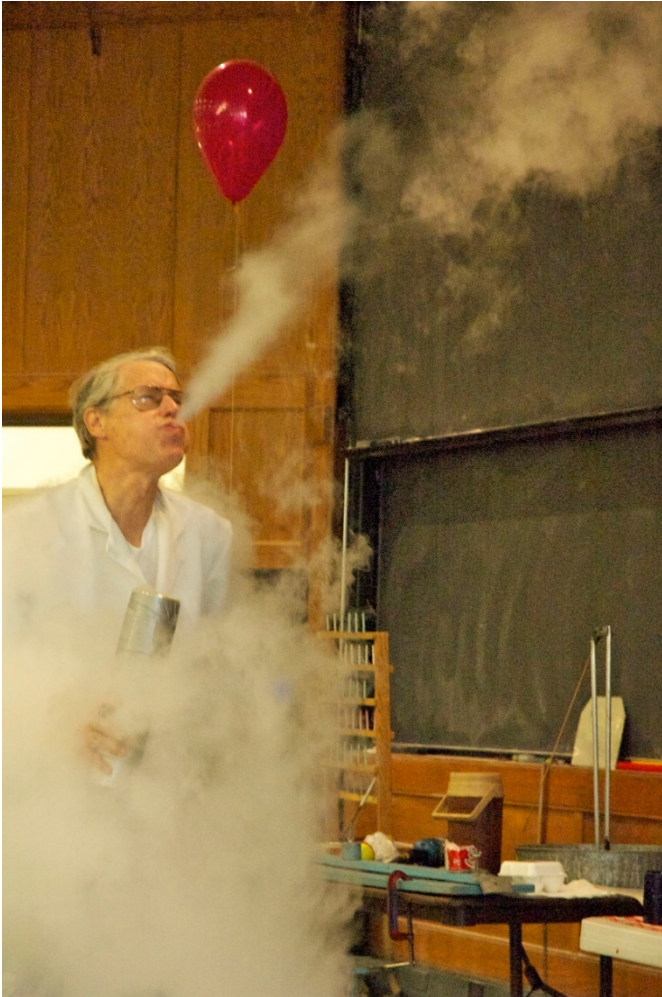
Sandy Martinuk
(*User Experience*)

Periscope Specialists



Rachel Scherr
Stephanie Chasteen

“Teach like a Scientist”



(Not This)

A) What does this mean?

B) What will you do?

What are you curious about?

How to compare teaching methods?

What are my students learning?

What materials are available?

What are communities creating?

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

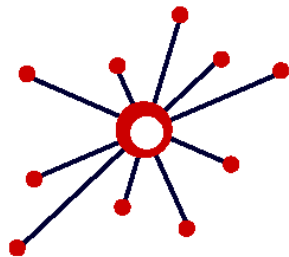
Faculty-centered
online resources

Synthesis
research

Conference Proceedings

Community Collections and Development

ComPADRE can help.



Vetted Library of Teaching and Support Resources

Free and Open Resources

Search
Browse
Collect
Share

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.

 **PhysPort**

Supporting physics teaching with research-based resources

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[Teaching Methods](#)

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[Workshops](#)

Expert Recommendations

FEATURED

Addressing common concerns about concept inventories

by Adrian Madsen, Sam McKagan and Eleanor Sayre July 8, 2016



Concept inventories are useful for assessing the effectiveness of your teaching, but as you use them, concerns and questions often come up. Here we discuss some common concerns about using concept inventories and related research

that addresses these concerns.

[Read more »](#)

[assessment](#), [concept inventories](#)

Where can I find good activities for small group discussions?

by Sam McKagan, PhysPort director

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

by Sam McKagan, PhysPort director

How can I get students to have productive discussions of clicker questions?

by Jenny Knight and Sarah Wise, University of Colorado - Boulder

Most Popular

[Normalized gain: What is it and when and how should I use it?](#)

[Arguments for skeptical colleagues](#)

[How can I design an effective in-class student worksheet for PhET simulations?](#)

[View all »](#)

Tags

[active learning](#) [assessment](#) [best practices](#)
[clickers](#) [concept inventories](#) [cooperative groups](#) [Peer Instruction](#) [PhET Interactive Simulations](#) [physics education](#)
[research](#) [teaching](#)

Teaching Methods

physport.org/methods/

How do I know which way to teach?

The screenshot shows the PhysPort website interface. At the top, there's a navigation bar with 'Home', 'Expert Recommendations', 'Teaching Methods', 'Assessments', and 'Workshops'. Below this is the 'Teaching Methods and Materials' section. It features a search bar with the prompt 'Tell us about your course to find methods relevant to you.' and three dropdown menus for 'Any Subject', 'Any Level', and 'Any Setting'. A 'Submit' button is below these. On the left, there are filters for 'Student Skills Developed' and 'Instructor Effort Required'. The main content area displays '55 Research-Based Methods' sorted by 'Popularity'. Three methods are visible: 'Peer Instruction' (Level: MS, HS, IC, IM, UL, GS; Setting: +7), 'PhET Interactive Simulations' (Level: MS, HS, IC, IM, UL, GS; Setting: +2), and 'Teaching with Clickers' (Level: MS, HS, IC, IM, UL, GS; Setting: +4).

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

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

PhysPort
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 ?
- Observation protocol ?

Research Validation ?

- Gold star validation
- Silver validation
- Bronze validation
- Research-based

Translations

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) Electricity / Magnetism Content knowledge (circuits, electrostatics, magnetic fields and forces) Levels: Upper-level, Intro college Formats: Pre/post, Multiple-choice 45 min
	Force and Motion Conceptual Evaluation (FMCE) Mechanics Content knowledge (kinematics, forces, energy, graphing) 35 min

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

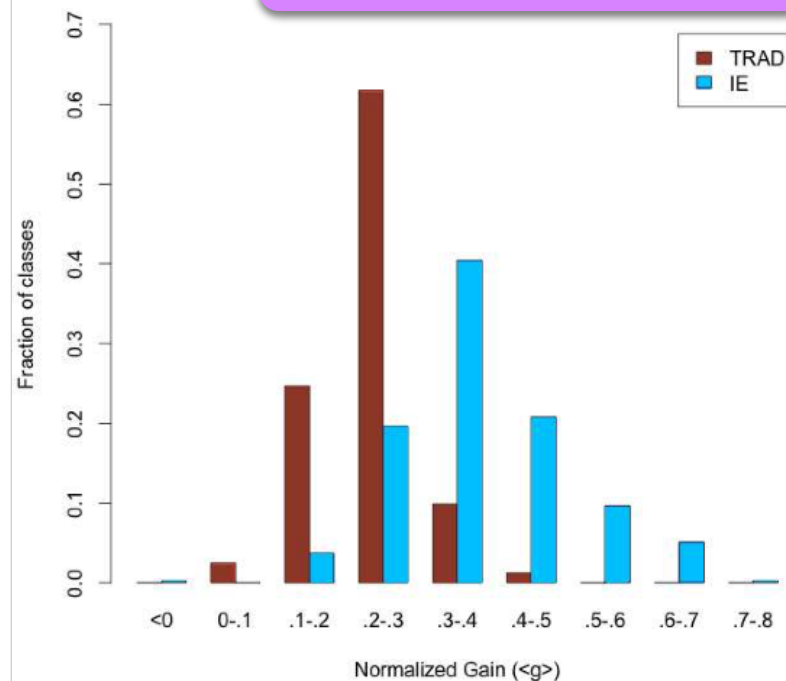
✔ By multiple research groups

✔ 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 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

Typical results



Where can I find things to use in my class?

Search

Browse

Vetted

Sharing

Details

Faculty-Focus

The screenshot shows the PSRC (Physical Sciences Resource Center) website. At the top, there is a search bar with the text "Find a Physics Resource..." and a "Search" button. Below the search bar is a navigation menu with links for "home", "browse resources", "forums", "filing cabinet", "submit a resource", "about the PSRC", and "sitemap". The main content area displays a search result for "PhET Simulation: Projectile Motion", published by the Physics Education Technology Project. The result includes a description of the simulation, a URL, and a table of metadata. The metadata table has columns for Subjects, Levels, Resource Types, Intended Users, Formats, and Ratings. The "Ratings" column shows a 4.7 star rating from 3 people. On the right side of the page, there are sections for "Supplements", "Contribute", "Related Materials", and "Similar Materials".

PSRC
PHYSICAL SCIENCES
RESOURCE CENTER

Find a Physics Resource... **Search**
advanced search

AAPT
login - register

home | browse resources | forums | filing cabinet | submit a resource | about the PSRC | sitemap

» home » Detail Page

Website Detail Page

PhET Simulation: Projectile Motion
published by the Physics Education Technology Project

This webpage contains a simulation that allows the user to fire various objects out of a cannon. By manipulating angle, initial speed, mass, and air resistance, concepts of projectile motion are illustrated. This page also contains user-submitted suggestions of ideas and activities for this simulation.

This item is part of a larger collection of simulations developed by the Physics Education Technology project (PhET). The simulations are animated, interactive, and game-like environments in which students learn through exploration. All of the simulations are freely available from the PhET web site for incorporation into classes.

<http://phet.colorado.edu/en/simulation/projectile-motion>

Subjects	Levels	Resource Types
Classical Mechanics - Applications of Newton's Laws - Motion in Two Dimensions = Projectile Motion	- Lower Undergraduate - High School - Middle School	- Instructional Material = Activity = Interactive Simulation

Intended Users	Formats	Ratings
- Learners - Educators	- application/flash	 Rated 4.7 stars by 3 people Want to rate this material? Login here!

Item Details | Related (7) | Comments (2) | Cite | Shared Folders (25)

Save to my folders

Supplements
[Comments \(2\)](#)
[Shared Folders \(25\)](#)

Contribute
[Make a Comment](#)
[Relate this resource](#)
[Contact us](#)

Related Materials
Is Part Of
[PhET: Physics Education Technology](#)
Is the Basis For
[phet.colorado.edu/...](#)
Is the Basis For
[phet.colorado.edu/...](#)
[More...](#)

Similar Materials
[Walter Fendt Physics Applets: Projectile Motion](#)
[NTNU Java: Two cannons aim at each other](#)

Open Source Physics

www.compadre.org/osp/

What are some special Collections?

The screenshot shows the Open Source Physics website interface. At the top, there is a navigation bar with the logo and user information: "Welcome Eleanor Sayre (le@zajosa.com) - my profile - AAPT link - logout - filing cabinet - suggest a resource - administrate". Below this is a search bar with the text "Search the OSP Collection." and buttons for "Search" and "Advanced".

The main content area is divided into several sections:

- SIMULATIONS**: A list of simulation categories including EJS MODELING, CURRICULUM, PROGRAMMING, TOOLS, JS/HTML MATERIALS, BROWSE MATERIALS, RELATED SITES, DISCUSSION, and ABOUT OSP.
- Computational Resources for Teaching**: A section describing the OSP Collection's resources for engaging students in physics, computation, and computer modeling. It includes a link to "Browse the OSP simulations" and a "Tracker" tool description.
- Tracker**: A detailed description of the Tracker tool, which extends traditional video analysis by enabling users to create particle models based on Newton's laws. It includes a link to "Learn more about Tracker".
- EJS Modeling**: A section describing student modeling using guided exploration of physical systems and concepts, with a link to "Learn more about EJS".
- Programming**: A section describing extensive resources for computational physics and physics simulations, including a list of resources: "An Eclipse environment for OSP", "OSP Source Code Libraries", "OSP best practices", and "Documentation". It also includes a link to "Access programming resources".
- Tools**: A section listing general applications for physics teaching, student activities, and curriculum distribution, including "Launcher", "Tracker", "EJS", and "Data Tool".
- Featured Tracker Package**: A section featuring "Projectile Motion with Angry Birds", which uses the Tracker tool to analyze the motion of an angry bird. It includes a screenshot of the simulation and a link to "More...".
- Curriculum Packages**: A section for curriculum resources.
- Newest OSP Materials**: A list of recent materials with dates and titles, such as "Physlet@ Waves and Oscillations Problems Package" (May 26), "Physlet@ Physics Periodic Motion Problems JS Package" (May 24), "Solar and Lunar Eclipse JS Model" (May 13), and "Celestial Sphere with Analemma JS Model" (Apr 24).
- Recently Updated Materials**: A list of recently updated materials, including "STP Textbook Chapter 9: Critical Phenomena" (Jun 10), "STP Textbook Errata supplement" (Jun 10), "Two-Body Orbits JS Model" (May 8), and "Open Source Physics Users Guide supplement" (Mar 20).
- Recent Library Comments**: A section for recent library comments, including "Jun 08 - 2:22 PM EST Jason Diemer posted Physlets won't... to the Physlet Physics (2e) Online thread."
- Recent Discussions**: A section for recent discussions, including "Jun 13 - 5:22 AM EST Léo Macena posted Re: Re:... to the Introducing a... thread." and "Jun 06 - 2:38 PM EST André Cunha posted Need old version... to the Can...".

As Seen
on
Tuesday

Questions so far?

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

For A & B:

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

Histogram for your class: Physics for Engineers Fall 2013 BEMA

Normalized Data
Mean: 0.20
Median: 0.18
Mode: 0.22
N: 453 students

Explore assessment data

Where can I find good questions to use with clickers or Peer Instruction?
by Sam McKagan, PhysPort director
September 26, 2016

Many research-based teaching methods in physics, including Peer Instruction, CAE Think-Pair-Share, Technology Enhanced Formative Assessment, and teaching with clickers, involve having your students discuss and answer multiple-choice conceptual questions. A challenge of using these methods is finding and writing good questions. This recommendation helps you find and write questions for your class.

Peer Instruction, CAE Think-Pair-Share, clickers, Technology-Enhanced Formative Assessment [Read more...](#)

compadre.org/osp

Open Source Physics

For C:

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



New Faculty Workshop - Introduction

Techniques for all size classes

Learner-Centered Instruction in Physics and Astronomy
Dr. Edward Fether, University of

PhysPort

AAPT 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



What is Periscope?

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

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?

[Modeling Instruction](#), [mechanics](#), [forces](#), [friction](#), [Florida International University](#)



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.



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.

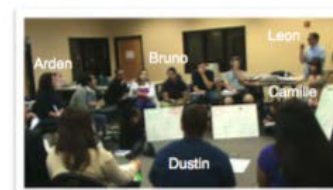
HANDOUT

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?

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"

(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 does not fall? The coefficient of static friction between the block and the cart is μ_s .

Sample discussion prompts

1. What did you observe in this episode? Talk to your group about what you saw.
2. The instructor (Leon) has been quiet for a while. What do you think he is thinking about? What message is he trying to convey?

Available now!

66 lessons
Facilitators' Guide

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.



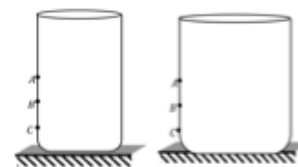
Episode: "Depth"

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.



Sample discussion prompts

- What did you notice** in this episode? Talk to your neighbor about what you noticed.
- 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?
- What does Levi **do (nonverbally)** to support the students in expressing themselves?
- 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?
- What instructor behaviors facilitate student learning**, as suggested in this episode?








Periscope

physport.org/periscope

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

I want to lead a weekly TA/LA seminar	I want to lead a half-day TA/LA workshop	I want to prepare colleagues to use best practices
I want to prepare colleagues to design learning environments	I want to prepare colleagues to train TAs/LAs	I want to teach TAs/LAs what ideas students have about a particular physics topic
I want to teach TAs/LAs about a particular instructional method	I want to support underrepresented groups	I want to improve my own teaching
I want to see all lessons in the Periscope collection		Download All

Use these Periscope lessons to reflect on classroom practices and interactions in order to better listen to and interpret students in your own classrooms. X

 Best Practices for Teaching (2 lessons)	 When It's Right to Be Wrong (2 lessons)	 Collaborative learning (8 lessons)	 Physics Feng Shui (1 lesson)
 Dissatisfied Students (5 lessons)	 Interactions in Diverse Classrooms (1 lesson)	 Tasks to Stimulate Deep Thinking (1 lesson)	

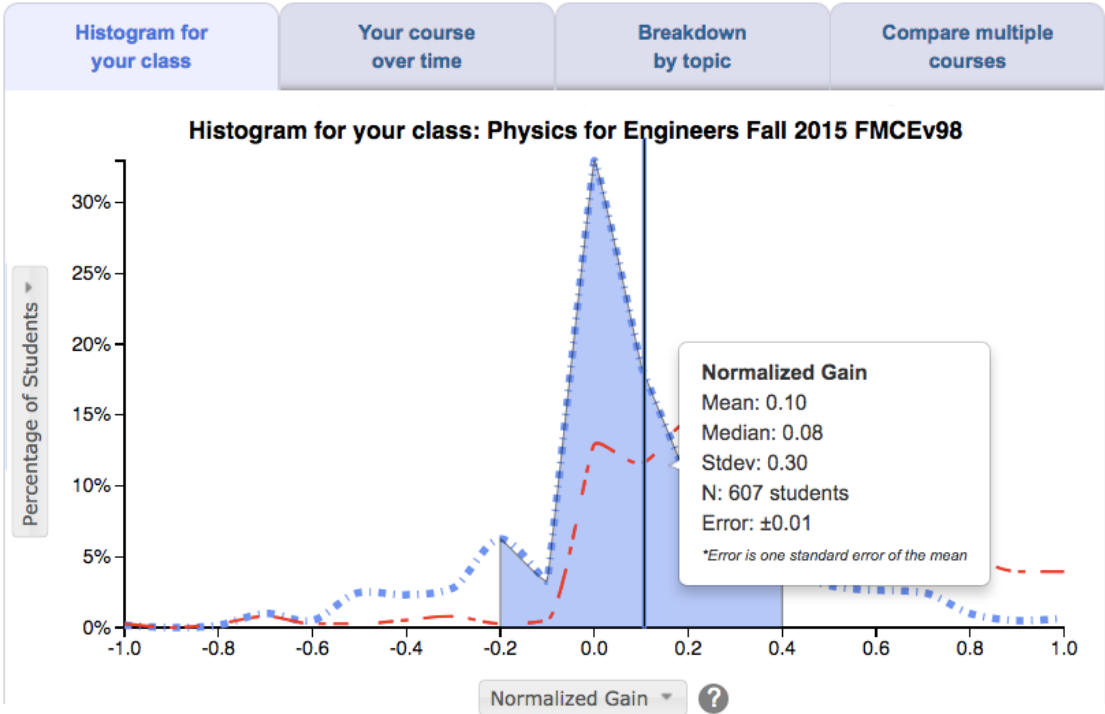
Available now!
66 lessons
Facilitators' Guide

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

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 $18\% \pm 1\%$ on the pre-test to $30\% \pm 1\%$ 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

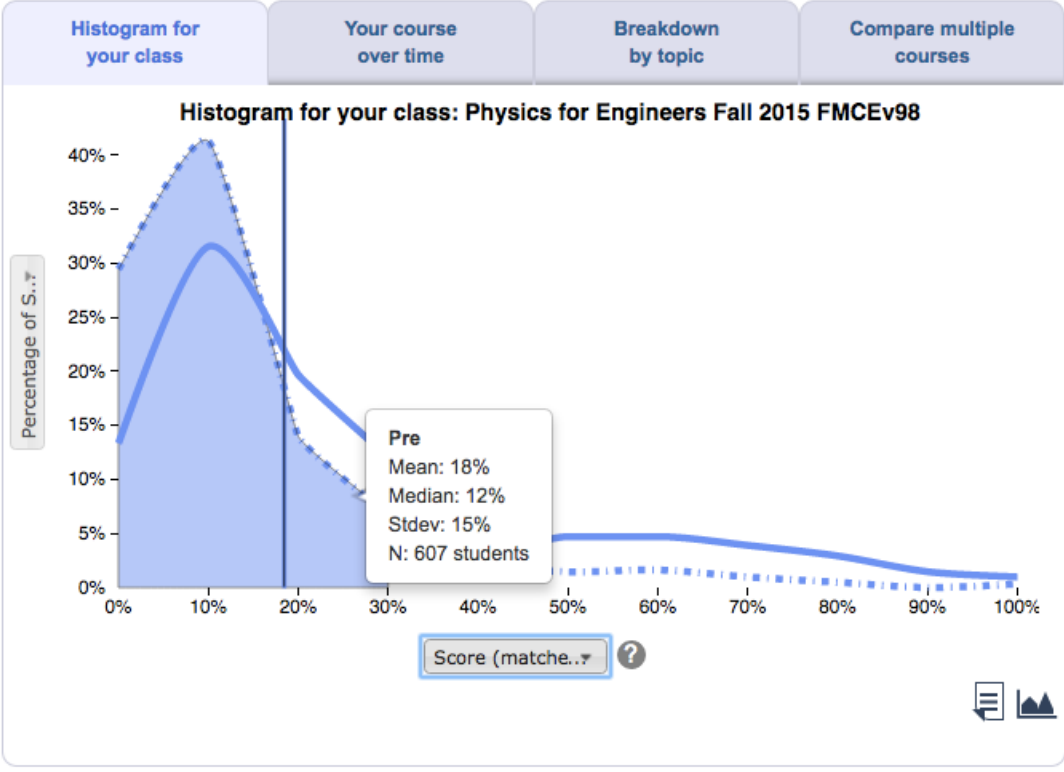
Courses that are taught using interactive engagement techniques tend to have higher normalized gains than those using traditional lecture. The key to these methods is getting students actively engaged in constructing their own understanding and not just passively listening.

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.

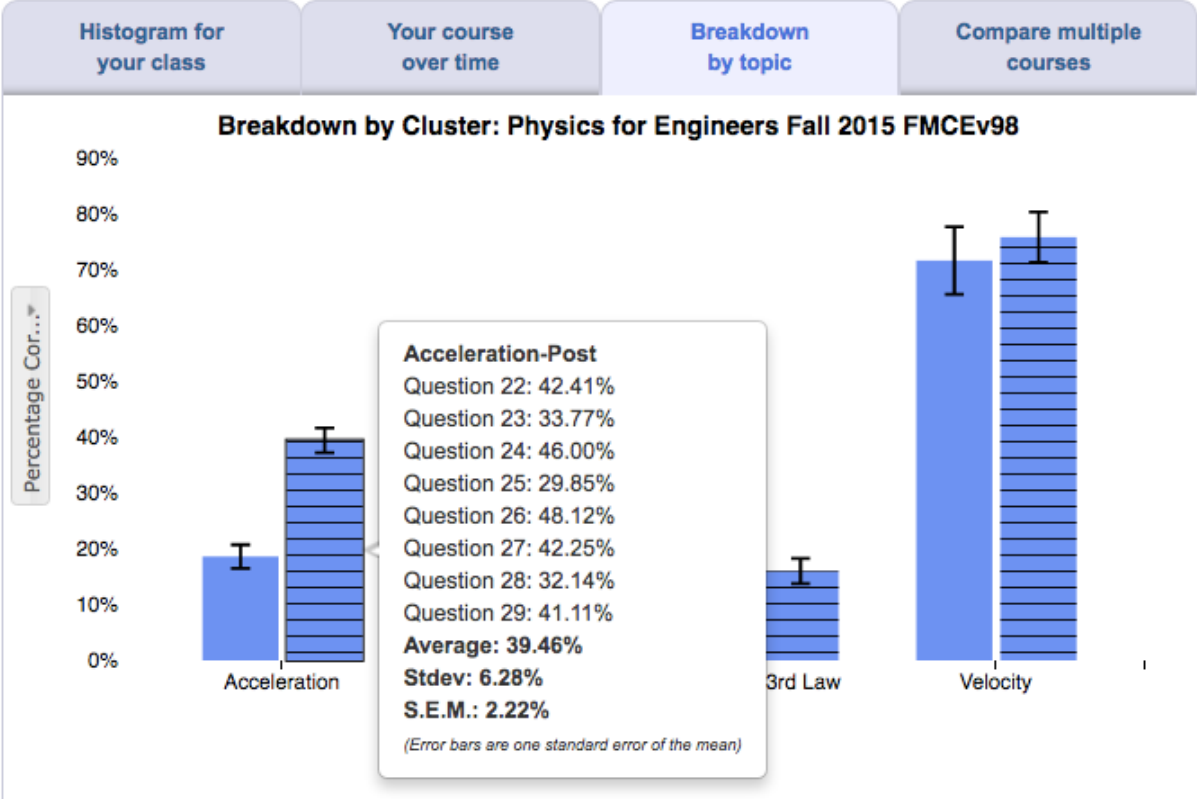
Data Explorer

physport.org/DataExplorer



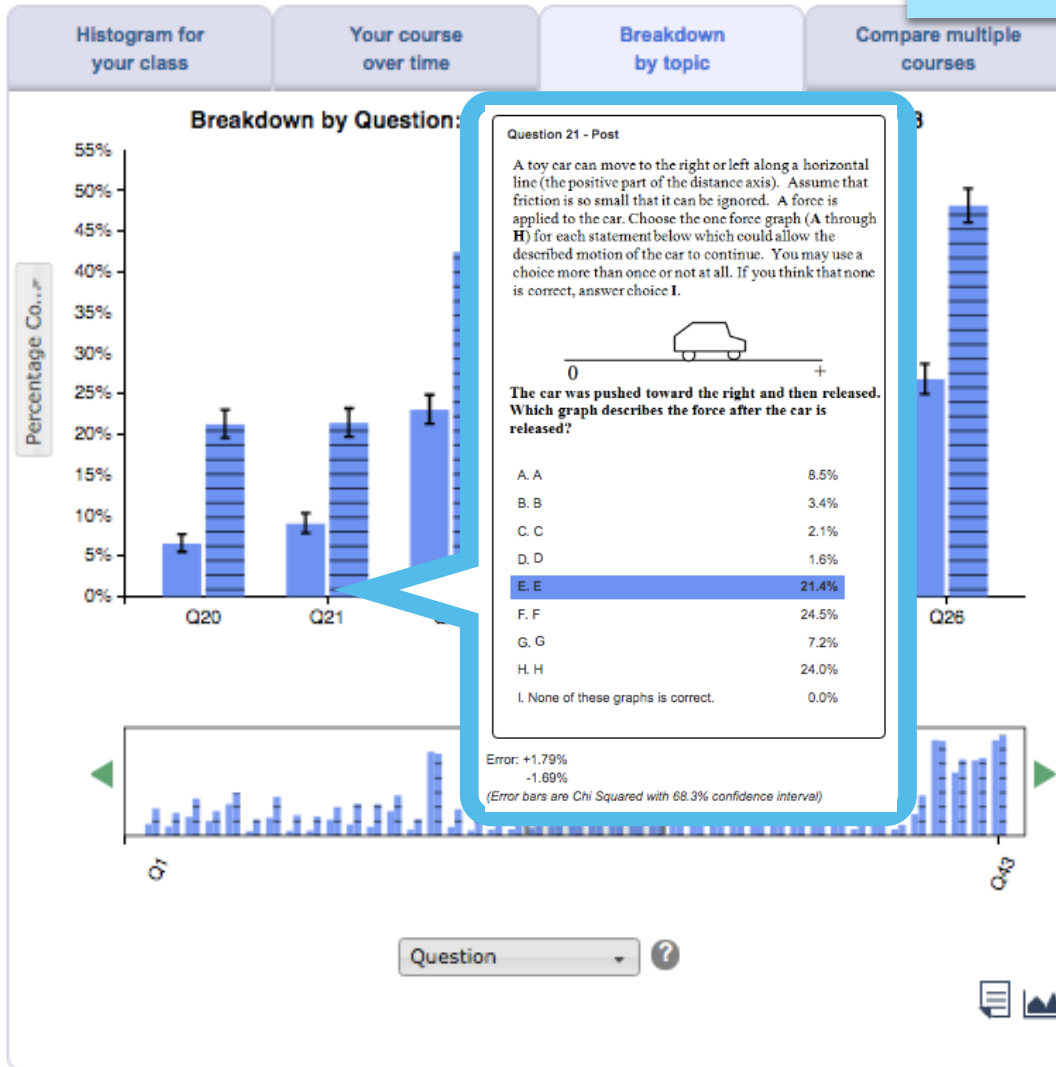
Data Explorer

physport.org/DataExplorer



Data Explorer

physport.org/DataExplorer



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

Filing cabinet

bit.ly/compadre-nfw

APPT ComPADRE
Resources and Services for Physics Education

filing cabinet - logout - help

The AAPT ComPADRE Collections | Events | Collaborate | Find a Resource... | Search | Advanced

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Home » Member Directory » Bruce, ComPADRE Dir » Shared Folders » Folder

My Folders

Bruce, ComPADRE Dir's Shared Folder

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 environments are created to encourage student exploration and inquiry. Both Java and HTML 5 simulations are available.
[details](#) - [website](#)
- Open Source Physics**
The OSP Digital Library provides a wide range of Java and Javascript (HTML 5) simulations and educational resources for physics, engineering, and modeling. It also includes the tools to allow users to build or edit simulations to meet their specific needs.
[details](#) - [website](#)
- Waves: An Interactive Tutorial**
This is a simulation-based tutorial on the physics of waves. Topics range from the basics of oscillation to dispersion relations and Fourier series and electromagnetic waves.
[details](#) - [website](#)

Copy selected into:

New Faculty Workshop - Digital Libraries Subfolders

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

Interactive eBooks

Sound: An Interactive eBook *by Kyle Forinash and Wolfgang Christian* Hosted by AAPT ComPADRE

1. Physics of Vibrations 2. Waves 3. Sound and Perception 4. Electromagn

Sound: An Interactive eBook

This book consists of 33 interactive simulations which require the reader to click buttons, move sliders, etc. in order to answer questions about the behavior of waves and sound in particular. There are also dozens of links to YouTube videos and other online resources that pertain to the topics being covered as well as suggestions for laboratory exercises and sound clips for understanding the fascinating subject of sound and music. The goal was to create an engaging text that integrates the strengths of printed, static textbooks and the interactive dynamics possible with simulations to engage the student in actively learning the physics of sound.

- 1. [Physics of Vibrations](#)
- 2. [Waves](#)
- 3. [Sound and Perception](#)
- 4. [Electromagnetism and Sound Reproduction](#)

[About this book](#)

Hosted by AAPT ComPADRE as a
Released under a Cre

www.compadre.org/books/SoundBook

Waves: An Interactive Tutorial *by Kyle Forinash and Wolfgang Christian* Hosted by AAPT ComPADRE

1. Basic Properties 2. Combining Waves 3. External Interactions 4. Applications

Waves: An Interactive Tutorial

This online book uses a series of tutorials based on interactive simulations and animations to explore the physics of waves. Students develop their understanding of waves through guided questions and exercises based on these simulations.

- 1. [Basic Properties](#)
- 2. [Combining Waves](#)
- 3. [External Interactions](#)
- 4. [Applications](#)

[About this book](#)

This is a set of interactive tutorials designed to teach the fundamentals of wave dynamics. It starts with very simple wave properties and ends with an examination of nonlinear wave behavior. The emphasis here is on the properties of waves which are difficult to illustrate in a static textbook figure. The tutorial may be used in conjunction with a text or as a stand alone introduction to waves. Exposure to calculus and basic physics is assumed in the latter sections.

NOTE: The simulations are now all in JavaScript and have been tested to run in Chrome and Firefox browsers with JavaScript enabled. They should also run in those browsers on tablets and smart phones.

Disponible en español: <http://pages.iu.edu/~kforinas/Ondas/WavesJS.html> (available in Spanish)

Introduction to Waves Tutorial

More about the design and goal of this tutorial, with a simple example.

[ready-to-run](#) - [details](#)

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www.compadre.org/books/wavesintut

Data

Synthesis research

Interpret the results of diverse PER studies

Weighted combination of published studies

More robust than single study

Vulnerable to publishing bias

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*

Mechanics teaching

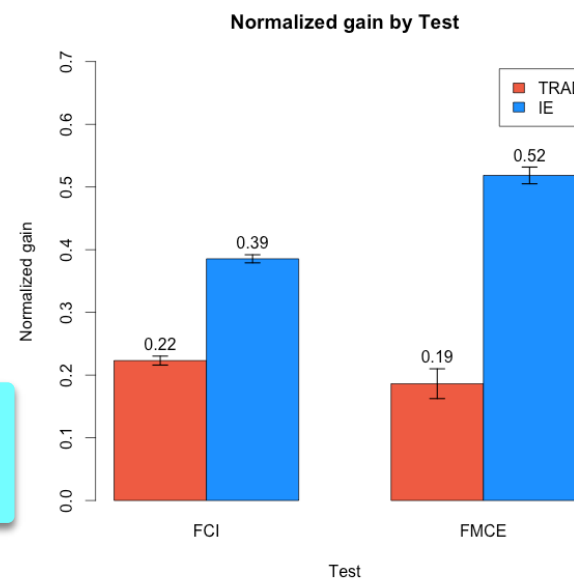
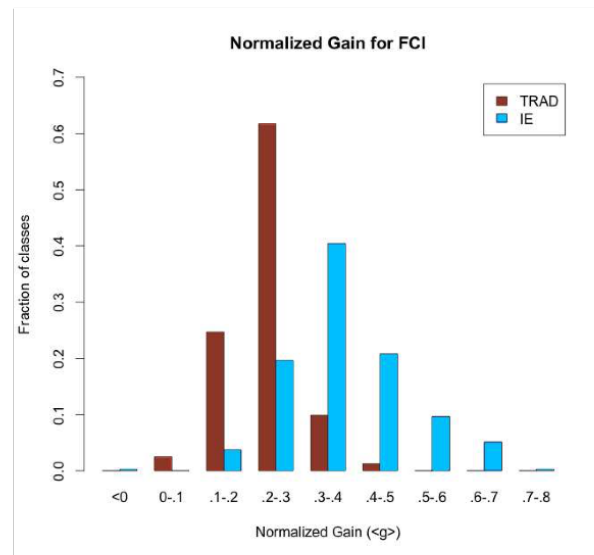
active learning
students do stuff
many different ways

Interactive
engagement
is better than
traditional lecture

chalk-and-talk
sage on the stage
cookbook labs



50,000 Students



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.

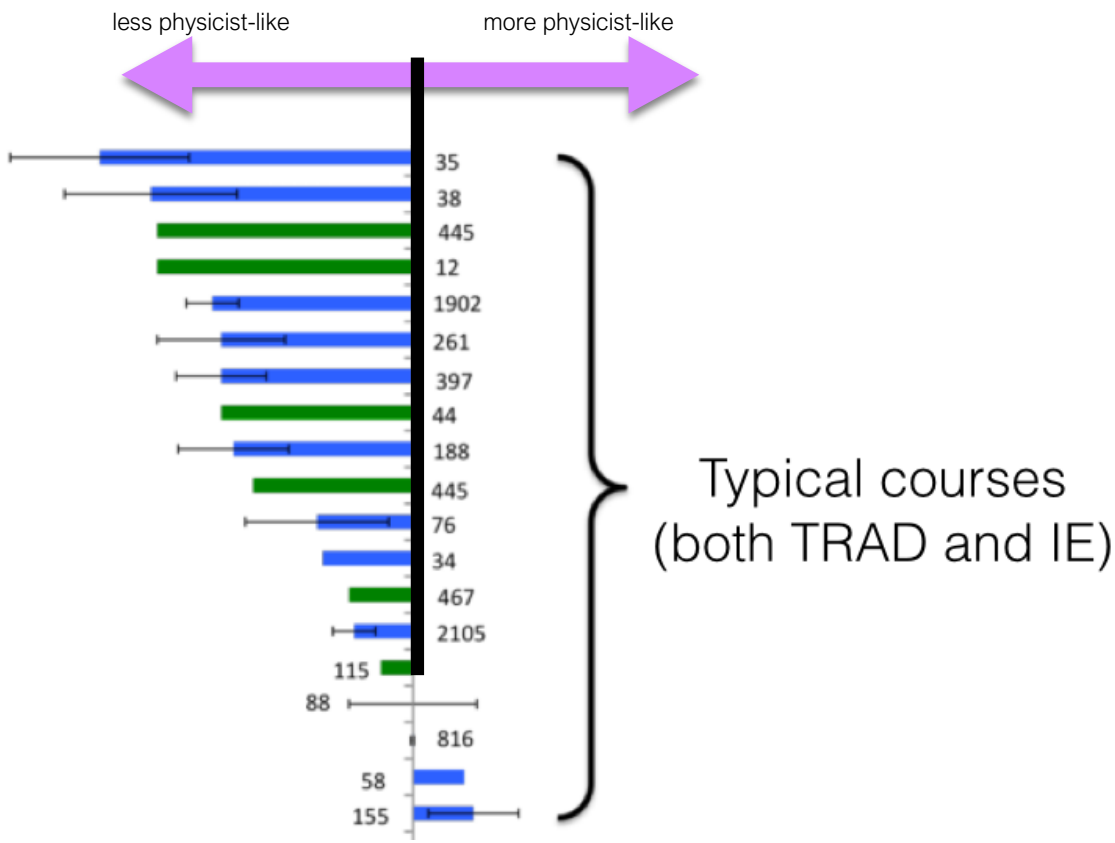
Strongly Disagree | 1 2 3 4 5 | Strongly Agree

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.



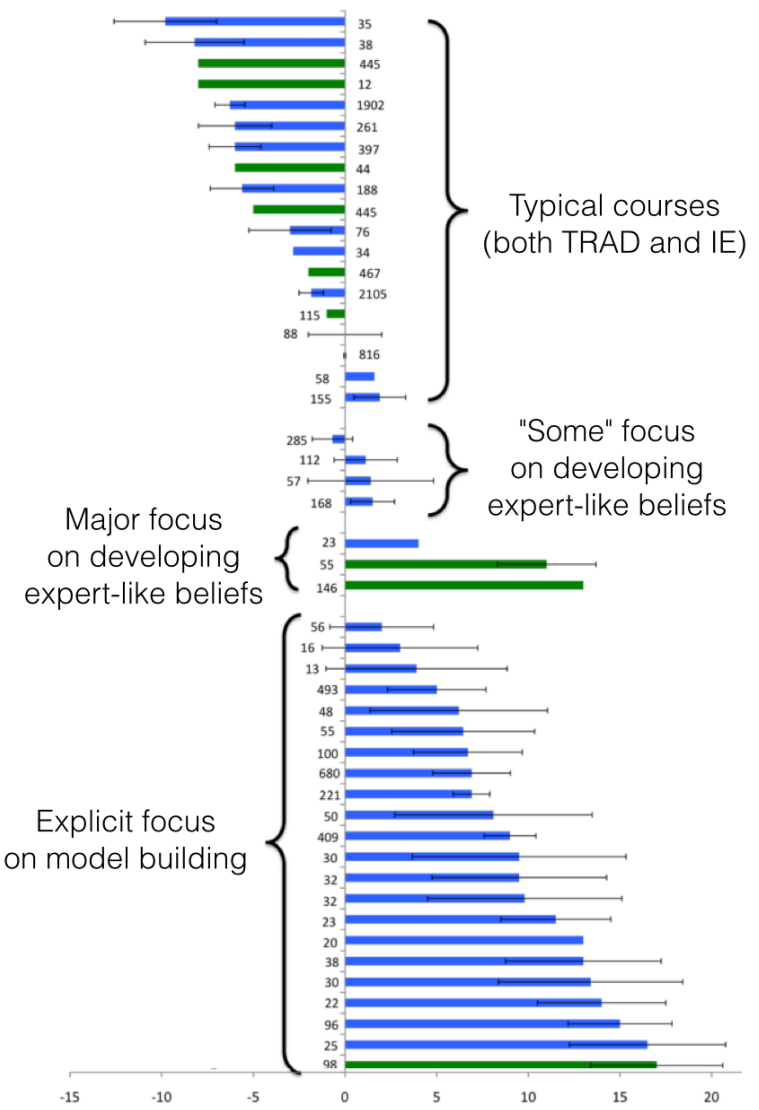
Madsen, A. M., McKagan, S. B., & Sayre, E. C. (2015). How Physics Instruction impacts students' beliefs about learning physics. *Physical Review Special Topics — Physics Education Research*.

Student Beliefs

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

"Ordinary" IE is not enough.

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

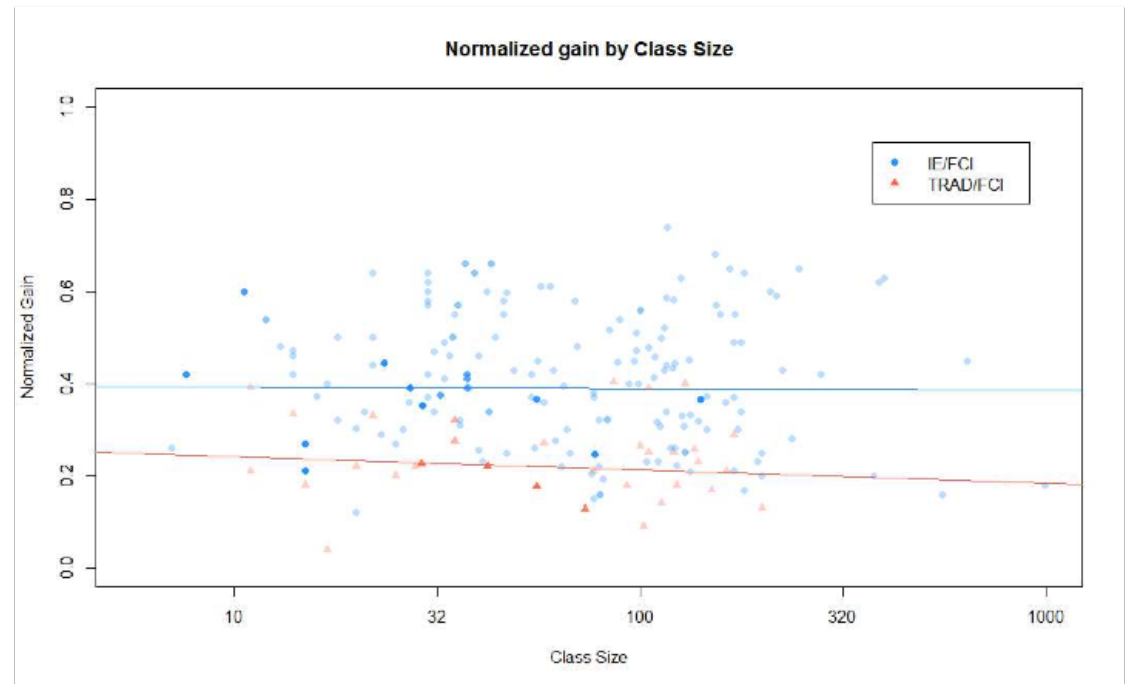


Madsen, A. M., McKagan, S. B., & Sayre, E. C. (2015). How Physics Instruction impacts students' beliefs about learning physics. *Physical Review Special Topics — Physics Education Research*.

Does class size matter?

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

no.



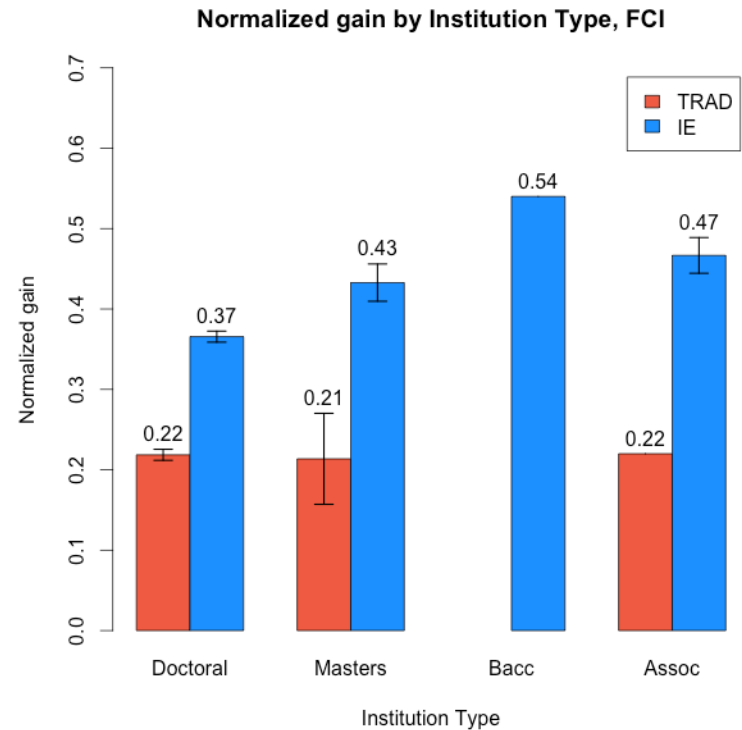
Von Korff, J., *et al* (2016). Secondary Analysis of Teaching Methods in Introductory Physics : a 50k - Student Study. American Journal of Physics

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

Gender gaps in learning physics

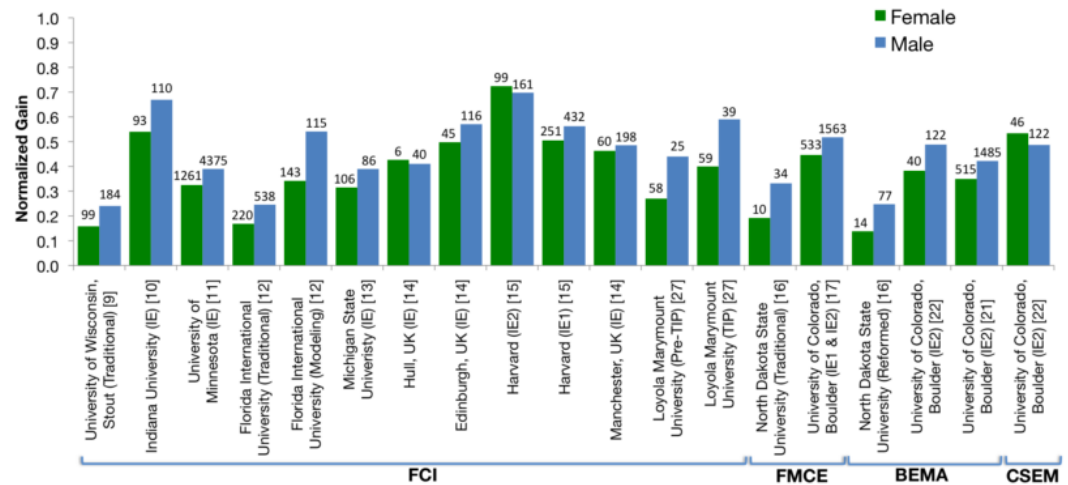
Men outperform women on RBAs

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.

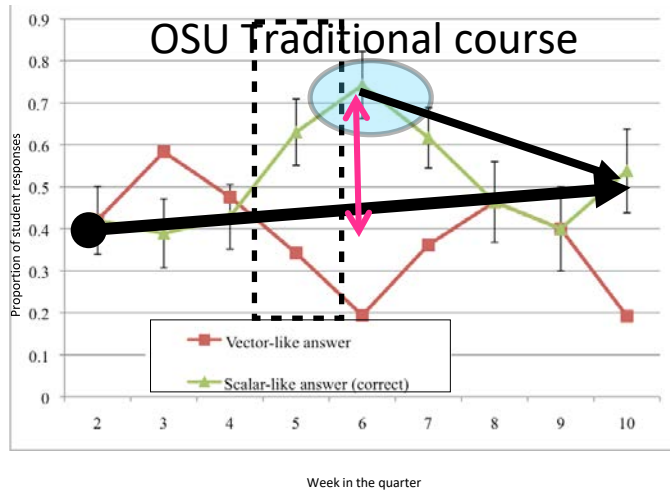


Madsen, A., McKagan, S. B., & Sayre, E. C. (2013). Gender gap on concept inventories in physics: What is consistent, what is inconsistent, and what factors influence the gap? *Physical Review Special Topics - Physics Education Research*, 9(2), 020121.

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

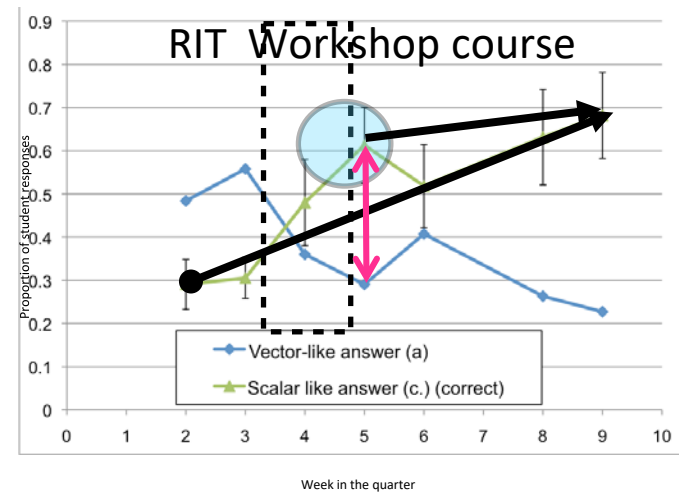
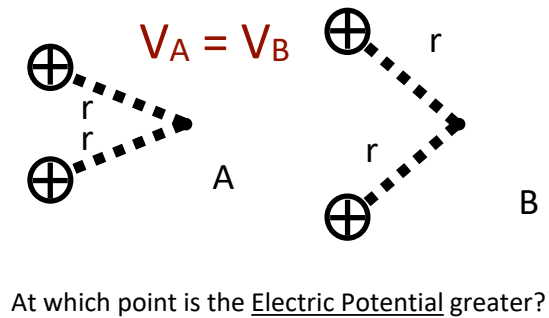
Different teaching methods



$$\langle g \rangle = 0.25$$

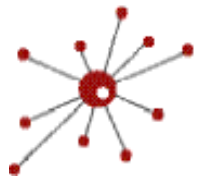
Both classes learn the same amount during instruction, but the reformed class fails to forget afterwards.

Traditional classes are traditionally disappointing.



$$\langle g \rangle = 0.5$$

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



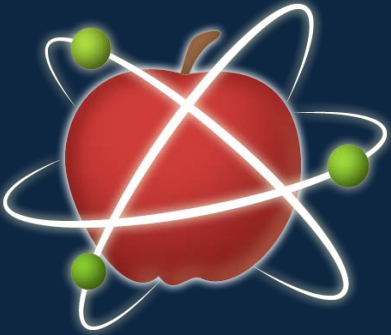
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Resources for Physics & Astronomy Education

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Digital Library: Collections of
web-accessible materials

Don't Re-Invent the Wheel!



PhysPort

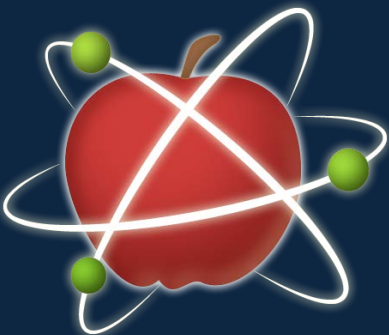
Supporting physics teaching
with research-based resources

physport.org



Don't Re-invent the Wheel!

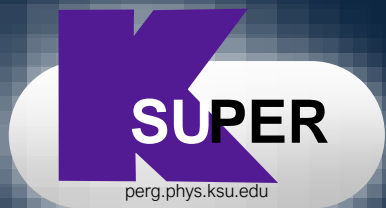
- Synthesis research
- Expert recommendations
- Teaching method search
- Assessment search
- Data explorer
- Online workshops



PhysPort

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with research-based resources

physport.org



Learn about better teaching!

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Read recommendations from experts

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