Research-based Resources
PhysPort & ComPADRE

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ComPADRE: Platform, Services, Resources

Research-Based Resources

Open Source Physics

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

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Bruce Mason, bmason@ou.edu
“Teach like a Scientist”

A) What does this mean?

B) What will you do?

(Not This)
Faculty have big questions.

- How to compare teaching methods?
- What are my students learning?
- What are communities creating?
- What materials are available?
- What works best for my context?
- How do I prepare TAs?
- How do I support diverse learners?
- course
- program

What are you curious about?
NFW is overwhelming.

PhysPort can help.

Finding information and advice

Changing teaching practices

Supporting physics teaching with research-based resources

Faculty-centered online resources

Synthesis research
ComPADRE can help.

Conference Proceedings

Community Collections and Development

Free and Open Resources

Vetted Library of Teaching and Support Resources

Search Browse Collect Share
Expert 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?
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Teaching 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
Assessment Resources

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

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.

Typical results

Research summary

Bruce Mason, bmason@ou.edu
Where can I find things to use in my class?

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
- Classical Mechanics
  - Applications of Newton’s Laws
  - Motion in Two Dimensions
    - Projectile Motion

Levels
- Lower Undergraduate
- High School
- Middle School

Resource Types
- Instructional Material
- Activity
- Interactive Simulation

Intended Users
- Learners
- Educators

Formats
- application/flash

Ratings
Rated 4.7 stars by 3 people. Want to rate this material? Login here.

Bruce Mason, bmason@ou.edu
Open Source Physics

What are some special Collections?

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.

**EJS Modeling**

The EJS Modeling package provides tools for student modeling, the guided exploration of physical systems and concepts, and 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.

**Curriculum Packages**

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

For C:

compadre.org/osp
Advanced Labs
compadre.org/advlabs
Computation in UG Phys
compadre.org/picup

For D:

compadre.org/books/nfwdl
Online workshops: Periscope & NFW

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

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
Periscope

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

How can I best facilitate a student discussion?

Available now!
66 lessons
Facilitators' Guide
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 physical 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?
Periscope

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

Available now!
66 lessons
Facilitators' Guide

physport.org/periscope
Data Explorer

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

### Summary

- **Average Gain**: 0.10 ± 0.01
  - This 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-tests) 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.

[physport.org/DataExplorer](physport.org/DataExplorer)
Data Explorer

physport.org/DataExplorer
Data Explorer

Breakdown by Cluster: Physics for Engineers Fall 2015 FMCEv98

- Acceleration-Post
  - Question 22: 42.41%
  - Question 23: 33.77%
  - Question 24: 46.00%
  - Question 25: 29.85%
  - Question 26: 48.12%
  - Question 27: 42.25%
  - Question 28: 32.14%
  - Question 29: 41.11%
  - Average: 39.46%
  - Stdev: 6.28%
  - S.E.M.: 2.22%

(Error bars are one standard error of the mean)
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

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


Mechanics teaching

Interactive engagement is better than traditional lecture

Active learning: students do stuff many different ways

Chalk-and-talk: sage on the stage

Cookbook labs: students do stuff many different ways

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

**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

Student Beliefs

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

"Ordinary" IE is not enough.

Student Beliefs

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

"Ordinary" IE is not enough.

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

Does class size matter?

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

no.

Does institution type matter?

- Reduced Carnegie classification
- Only US schools

no.

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

Gender gaps in learning physics

Men outperform women on RBAs
- Mechanics: Men = 0.43; Women = 0.37
- E&M: Men = 0.42; Women = 0.36

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.

## Gender gap: causes

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

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
Digital Library: Collections of web-accessible materials

Don’t Re-Invent the Wheel!
Don’t Re-invent the Wheel!

- Synthesis research
- Expert recommendations
- Teaching method search
- Assessment search
- Data explorer
- Online workshops
Learn about better teaching!
Search for teaching methods
Read recommendations from experts

Be a PhysPort verified educator!
Download assessments
Take online workshops

Do Physics Education Research!
Discover how students learn
Build better pedagogy

Email us to learn more:
smckagan@aapt.org
esayre@ksu.edu