Research-based resources on PhysPort

Eleanor C Sayre,
Sam McKagan,
Adrian M Madsen

NFW
November 2017

NSF
DUE-1430967,
DUE-1347821,
DUE-1347728,
PHYS-1461251

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What is PhysPort?

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)
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
Faculty have big questions.

- How to compare teaching methods?
- Which assessment should I use?
- How do I prepare TAs?
- How do I support diverse learners?
- What works best for my context?
  - course
  - program

Eleanor Sayre, esayre@ksu.edu
PhysPort can help.

Supporting physics teaching with research-based resources

Finding information and advice

Changing teaching practices

Faculty-centered online resources

Synthesis research

NFW is overwhelming.
go here now.

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

Real questions. Research-based answers. Faculty-centered resources.

Have a suggestion? esayre@ksu.edu
Want to contribute? smckagan@aapt.org
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
Now that I want that, where can I get it?

Physport's parent: compadre.org

- lab ideas
- clicker questions
- tutorials
- teaching materials

collections of teaching materials free!
Open Source Physics

www.compadre.org/osp/

parallel session
Advanced Labs

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.

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

NFW collection
Make your own collections!

bit.ly/compadre-nfw
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
Assessment Resources

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
Force Concept Inventory

**RESEARCH VALIDATION SUMMARY**

Based on Research Into:
- ✔ Student thinking
- ✔ Student interviews
- ✔ Expert review
- ✔ Appropriate statistical analysis

Studied Using:
- ✔ 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 these 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. Including data on 100000 students.

**Research summary**

![Typical results chart]

**Normalized Gain (<g>)**

- TRAD
- IE

**Fraction of classes**

- <0
- 0.1
- 0.2
- 0.3
- 0.4
- 0.5
- 0.6
- 0.7

**PhysPort.org**

Eleanor Sayre, esayre@ksu.edu
Data Explorer

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

physport.org/DataExplorer

Upload your data

Explore your data

Download a report
Online workshops

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

physport.org/workshops
Periscope

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

How can I best facilitate a student discussion?

What is Periscope?

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?

Self Study
You can also use Periscope lessons for self-study by watching the video episodes 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 open both the episode and the handout on a large screen.

Available now!
66 lessons
Facilitators' Guide

physport.org/periscope
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

\[ <g> = 0.25 \]

Different teaching methods

OSU Traditional course

RIT Workshop course

\[ \langle g \rangle = 0.25 \]

\[ \langle g \rangle = 0.5 \]

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

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!

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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")

What are physicists?

Sophomores

<table>
<thead>
<tr>
<th>High Research</th>
<th>Low Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doing independent research</td>
<td>Having a physics mindset</td>
</tr>
<tr>
<td>Doing research</td>
<td>Being committed to physics</td>
</tr>
<tr>
<td>Having a deep understanding</td>
<td>Having a deep understanding</td>
</tr>
</tbody>
</table>

Seniors

<table>
<thead>
<tr>
<th>High Research</th>
<th>Low Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doing independent research</td>
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</tbody>
</table>

Charlie

Oliver

Ed

Will

Jack

Larry

Danny

Prepared non-faculty physicists

We are the 1%.
Preparation of non-faculty physicists.

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

We are the 1%.

The number of physics PhDs earned by Hispanic Americans has increased by about 30% in less than a decade.

The number of African Americans earning physics PhDs has not experienced a similar growth, with the number of degrees earned during the last decade averaging between 10 and 20 PhDs.

The proportion of physics PhDs earned by women reached an all-time high of 20% in the class of 2012. In the class of 2012, 20% of the physics PhDs were earned by women, this is up from 13% 11 years earlier. This increase along with a growth in the overall number of physics PhDs awarded has resulted in a sharp increase in the number of women receiving degrees. Women earned 354 of the physics PhDs in the class of 2012, up from only 153 in 2001 (a 131% increase).

The proportion of non-U.S. citizens earning physics PhDs who are women is higher than for U.S. citizens. Women comprised 23% of the non-U.S. citizens in the class of 2012 and 17% of the U.S. citizens.
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.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Highest physics degree offered by department} & \text{Calculus Based} & \text{Algebra Based} & \text{Conceptual} \\
\hline
\text{Bachelor's} & 49,000 & 48,000 & 30,000 \\
\text{Master's} & 18,000 & 18,000 & 13,000 \\
\text{PhD} & 112,000 & 87,000 & 32,000 \\
\text{Total} & 179,000 & 153,000 & 75,000 \\
\hline
\end{array}
\]

We estimate that more than 215,000 students were enrolled in a physics or physical science course in a two-year college during the academic year 2007-08.

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.

## 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, physics 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>
Organizing your knowledge

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

PhysPort can help.
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
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.

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.
Episode 101: “Depth”

Filmed at the University of Maryland using Open Source Tutorials
What instructor behaviors facilitate student learning?

- 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 this episode?
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