Using research-based assessment to improve teaching in your classroom and department:

New resources on PhysPort

Sarah B. McKagan
Adrian Madsen
Eleanor C. Sayre
PhysPort
Supporting physics teaching with research-based resources

(Formerly known as the PER User's Guide)

http://perusersguide.org

Available Now:
Resources on research-based teaching methods

Available this fall:
• Redesign and expansion of teaching methods
• New assessment resources
• New assessment data explorer
How do we do assessment in physics?

Physics classes:
• Exams
• Homework
• Teaching evaluations
• Assessment surveys

Physics departments:
• Drop-withdraw-fail rates
• Student retention
• Observations
• Assessment surveys

Focus on research-based assessment surveys
What are Research-based Assessment Instruments?

Force Concept Inventory (FCI)
Force Motion Conceptual Evaluation (FMCE)
and 50+ more

These are:
• Generally multiple-choice surveys
• Carefully crafted questions
• Conceptual topics across the physics curriculum
• Additionally: beliefs, problem-solving skills, affect
Research and Development Process

Faculty and Department Chair Interviews → Personas of Users → Site that meets real users’ needs

- Paula the Skeptic
- Raphael the Motivated Novice
- Diane the Pragmatic Satisficer
- Tim the Seeker
- Marge the Proto-researcher
Raphael’s Questions

- Which research-based assessment should I use?
- Where do I get the assessment?
- How should I administer the assessment?
- How did I do on this assessment?
- How do my assessment results compare to other students like mine?
- What kind of analysis should I do and what statistics should I use?
Diane’s Questions

• How do my results break down on a question-by-question basis?
• How do my results change over time?
• How do I use these results to make improvements in my class and department?
• When will I find the time to analyze my data?
Tim’s Questions

• How can I assess non-content skills?
• How do the results in my department vary across different courses and instructors?
• Is there a gender gap on these assessments in my class?
• What parts of my teaching really help my students learn?
Find an Assessment

Raphael the Motivated Novice

• Which research-based assessment should I use?

Diane the Pragmatic Satisficer

• Where do I get the assessment?

Tim the Seeker

• How can I assess non-content skills?
Content

**Force Concept Inventory (FCI)**
- Mechanics Content Knowledge (Kinematics, Forces)
- Introductory College
- Multiple-choice, Pre/post
  - 30 minutes

**Representational Variant of the Force Concept Inventory (R-FCI)**
- Mechanics Content Knowledge (Kinematics, Forces)
- Introductory College
- Multiple-choice, Pre/post
  - 30 minutes

**Test of Understanding Graphs in Kinematics (TUG-K)**
- Mechanics Content Knowledge (Kinematics, Graphing)
- Introductory College
- Multiple-choice, Pre/post
  - 30 minutes

Beliefs / Attitudes

**Colorado Learning Attitudes about Science Survey (CLASS)**
- Beliefs / Attitudes
- All levels
Find an Assessment

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

Any Subject

Any Level

Any Setting

Assessment Focus

Any
- Content knowledge
- Problem-solving
- Scientific Reasoning
- Lab skills
- Beliefs / Attitudes
- Interactive Teaching

Format

Any
- Multiple-choice
- Multiple-response
- Short answer
- Pre / Post
- Agree / Disagree
- Observational Protocol

Research Validation

Any
- Gold Star Validation
- Validated Level 2
- Validated Level 1
- Research-Based

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Learn about the Assessment

Raphael the Motivated Novice

Diane the Pragmatic Satisficer

- Which assessment should I use?
- Where do I get the assessment?
- How should I administer the assessment?

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- How can I assess non-content skills?
Force Concept Inventory (FCI)
developed by David Hestenes, Malcolm Wells, and Gregg Swackhamer
http://modelinginstruction.org/researchers/evaluation-instruments/

Format: Multiple-choice, Pre/post
Duration: 30 minutes
Focus: Mechanics Content Knowledge (Kinematics, Forces)
Level: Introductory
Example Question 1

A book is at rest on a table top. Which of the following force(s) is(are) acting on the book?

1. A downward force due to gravity
2. The upward force by the table
3. A net downward force due to air pressure
4. A net upward force due to air pressure

(A) 1 only

(B) 1 and 2

(C) 1, 2, and 3

(D) 1, 2, and 4

(E) none of these, since the book is at rest there are no forces acting on it.
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**Force Concept In**

developed by David Hestenes, Mail
http://modelinginstruction.org/new

**Format**
Multiple-choice, Pre/post

**Duration**
30 minutes

**Focus**
Mechanics Content Knowledge (I)

**Level**
Introductory

**Typical Results**

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</tbody>
</table>

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**Examples**

**Example Question 1**

A book is at rest on a table top. Which of the following statements is true?

1. A downward force due to gravity acts on the book.
2. The upward force by the table balances the downward force due to the weight of the book.
3. A net downward force due to gravity acts on the book.

(A) 1 only
(B) 1 and 2
(C) 1, 2, and 3
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(E) none of these, since the book is at rest.

---

**Related Expert Recommendations**

**Best practices for administering concept inventories**

**Should I use the FCI or the FMCE?**

**Why use research-based assessment?**

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**Related Assessments**

**Mechanics Baseline Test (MBT)**

**Force and Motion Conceptual Evaluation (FMCE)**

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**Related Teaching Methods**

**Modeling Instruction**

Instruction organized around active student construction of conceptual and...
FCI Implementation and Troubleshooting Guide

This guide covers all the information teachers would need to implement this assessment in their course. It also includes troubleshooting information and links to additional resources.
RESEARCH VALIDATION

**Gold Star Validation**
This is the highest level of research validation. This indicates that the assessment instrument has been thoroughly validated and researched.

---

**RESEARCH VALIDATION SUMMARY**

**Based on Research Into:**
- ✔️ Student thinking

**Studied Using:**
- ✔️ Student interviews
- ✔️ Expert review
- Statistical analysis

**Research Conducted**
- ✔️ At multiple institutions
- ✔️ By multiple research groups
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Best practices for administering concept inventories
Should I use the FCI or the FMCE?
Why use research-based assessment?

Related Assessments
Mechanics Baseline Test (MBT)
Force and Motion Conceptual Evaluation (FMCE)

Modeling Instruction
Instruction organized around active student construction of conceptual and mathematical models in an interactive learning community

Related Teaching Methods
view all >
Your identity is protected

Your students' identities are protected

We use one-way, cryptographically-secure transformations

We report on aggregate data

Visualize and Analyze Your Assessment Data

- We report on aggregate data
Visualize and Analyze Your Results

• How did I do on this assessment?
• How do my assessment results compare to other students like mine?
Visualize and Analyze Your Results

Your Data

- FCI - Physics 100 Fall 2010

Comparison Data

- Students Like Yours
- National

Normalized Gain

By

- Compare
- Multiple Courses
Summary

Your students’ average normalized gain of 0.3 is similar to the national average but statistically lower than “students like mine”. This means that students at similar institutions in similar course have higher gains than your students.

Courses taught using interactive engagement techniques have gains in the range from .18 to .66 with an average of .48. Your normalized gain is in the lower end of this range.

Recommendations

Large courses like yours that are taught using interactive engagement techniques tend to have higher normalized gains. 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 Simulations, Interactive Lecture Demos and Just In Time Teaching.
Your Results Over Time

- How do my results change over time?
Your Results Over Time

Histogram For Your Class

Your Course Over Time

Breakdown By Question

Compare Multiple Courses

Force Concept Inventory

Effect Size

Fall 2010
Fall 2011
Fall 2012

Your Data

Group Split

FCI - Physics 100 Fall 2010

FCI - Physics 100 Fall 2011

FCI - Physics 100 Fall 2012

Comparison Data

Students Like Yours

National Median
Question-by-Question Breakdown

• How do my results break down on a question-by-question basis?
• How do I use these results to make improvements in my class and department?
Question 2

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Question-by-Question Breakdown

Force Concept Inventory

Your Data
- Split
  - FCI - Physics 100 Fall 2010

Comparison Data
- Students Like Yours
- National Median

Percent of Students

Histogram For Your Class  
Your Course Over Time  
Breakdown By Question  
Compare Multiple Courses

By Question ▼
Question-by-Question Breakdown

Force Concept Inventory

Histogram For Your Class  Your Course Over Time  Breakdown By Question  Compare Multiple Courses

Your Data

Split

FCI - Physics 100 Fall 2010

Comparison Data

Students Like Yours

National Median

Third Cluster

Question 1 10%
Question 3 15%
Question 5 40%
Question 7 30%
Average 23.75%
Stdev 8%

Percentage ▼

0 20% 40% 60% 100%

First Cluster  Second Cluster  Third Cluster  Fourth Cluster  Fifth Cluster  Sixth Cluster

By Cluster ▼
Compare Multiple Courses

- How do the results in my department vary across different courses and instructors?
- Is there a gender gap on these assessments in my class?
Compare Multiple Courses

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Comparison Data
- Students Like Yours
- National Average

Force Concept Inventory

Effect Size

Instructor A

Instructor B
Compare Multiple Courses

Force Concept Inventory

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- Instructor A - Male
- Instructor A - Female
- Instructor B - Male
- Instructor B - Female

Comparison Data

- Students Like Yours
- National Average
Upload Assessment Results

• When will I find the time to analyze my data?
Add Metadata

Physics 101.xml: fall2013 section 2

School
University of Central Flatland

Instructor
Dr. Username

Course
Create a new course

Class
Create a new Class

Assessment
Add an Assessment
Physics 101.xml: fall2013 section 2

School
- University of Central Flatland

Instructor
- Dr. Username

Course
- Phys 100

Class
Create a new Class

Assessment
Add an Assessment
### Class Details

#### Semester/term class was taught:
- **Semester:**
- **Spring:**
- **Year:**

#### Style of instruction:

**Instructional Practices:**
- Instructor lectures: 30%
- Instructor lead whole class discussion: 20%
- Students work together in small groups: 20%
- Students work individually: 15%
- Students present to the whole class: 15%
- Other: 0%

**Is there anything else we didn’t ask you about that you think is important for characterizing your instructional practices?**

**Hours/week taught by primary instructor:**

**Experience teaching this course:**

---

**OK**

**Cancel**
Add Metadata

Physics 101.xml: fall2013 section 2

School: University of Central Flatland
Instructor: Dr. Username
Course: Phys 100
Class: Spring 2013
Assessment: FCI Pre and Post
## Confirm Auto Guesses in Your File

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For Q2:
- FCI Pre Question 1
- FCI Pre Score
- FCI Pre Other >
- Student Data
  - Course Grade
  - GPA
  - Major
  - Gender
  - Ethnicity
  - SAT score
  - ACT score
  - Highest level of math
  - High School Physics?
  - Class Standing
  - Expected Graduation Yr.
  - TOEFL score

- Do not import
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Tell us about the file you uploaded.

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Done
Download Your Report

FCI Results
Dr. Username, University of Central Flatland
Physics 100, Fall 2013

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Summer 2014: Beta Testing for Assessment Data Explorer
Sign-up sheet circulating around room.

Fall 2014: Assessment Resources Live
Email us to learn more:
smckagan@aapt.org

Project Website:
zaposa.com/home2/assessment-for-faculty