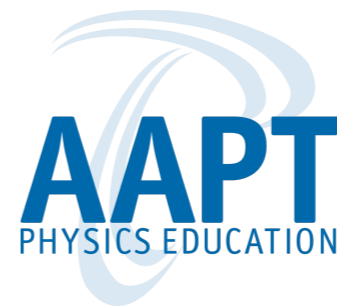


Using research-based assessment
to improve teaching in your
classroom and department:

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



Paula the Skeptic



Raphael the Motivated Novice



Diane the Pragmatic Satisficer



Tim the Seeker



Marge the Proto-researcher

Raphael's Questions



**Raphael the
Motivated
Novice**

- 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



**Diane the
Pragmatic
Satisficer**

- 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



**Tim the
Seeker**

- 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**



**Diane the
Pragmatic
Satisficer**

- Which research-based assessment should I use?
- Where do I get the assessment?



**Tim the
Seeker**

- How can I assess non-content skills?




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

Assessment Focus

Any

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

Content

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

Beliefs / Attitudes



Beliefs / Attitudes

ent

CI)

s, Forces)

🕒 30 minutes

the Force

s, Forces)

🕒 30 minutes

hs in

s, Graphing)

🕒 30 minutes

about

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

Content



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Introductory College

Multiple-choice, Pre/post

 30 minutes

Beliefs / Attitudes



Colorado Learning Attitudes about Science Survey (CLASS)

Beliefs / Attitudes



Browse Assessments



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

Any Subject



Any Level



Any Setting



Save Course

reset

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

Content



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Mechanics Content Knowledge (Kinematics, Forces)

Introductory College

Multiple-choice, Pre/post

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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

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?



**Tim the
Seeker**

- How can I assess non-content skills?

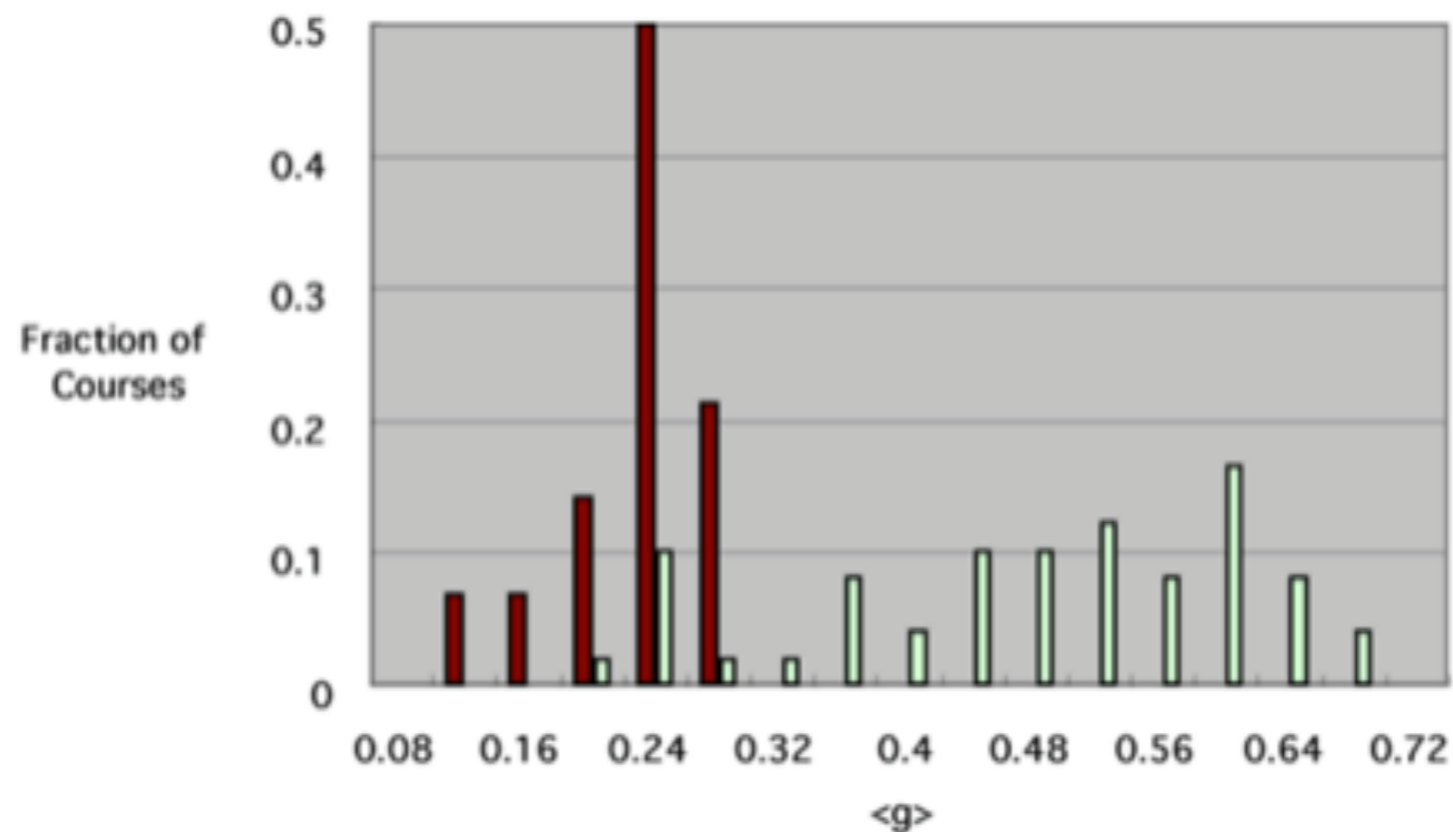
Force Concept Inventory (FCI)

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

Typical Results



Explore
More
Results



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.

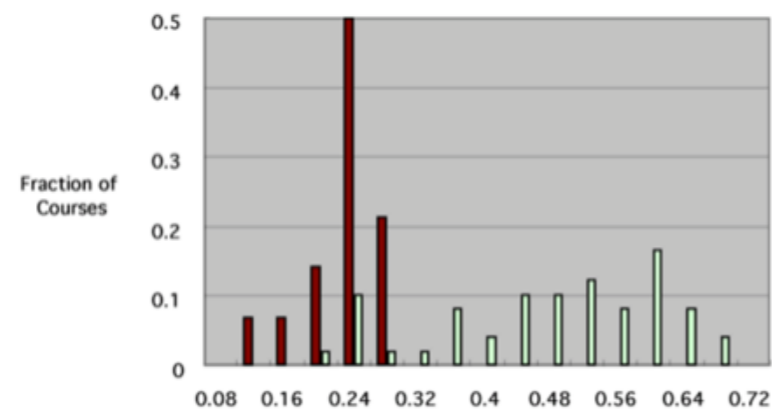
Force Concept Inventory (FCI)

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

Typical Results



Explore
More
Results

Examples

Resources



Research



Translations

Variations

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

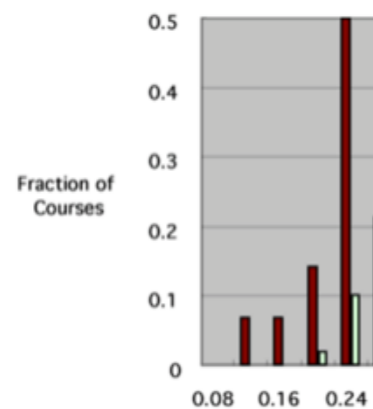
(E) none of these, since the book is at rest there are no forces acting on it.

Force Concept Inventory

developed by David Hestenes, Mal
<http://modelinginstruction.org/res>

Format	Multiple-choice, Pre/post
Duration	30 minutes
Focus	Mechanics Content Knowledge (I
Level	Introductory

Typical Results



Examples

Resources



R

Example Question 1

A book is at rest on a table top. Which

1. A downward force due to the weight of the book
2. The upward force by the table
3. A net downward force due to the weight of the book
4. A net upward force due to the table

(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

Related Expert Recommendations

[view all >](#)

**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)**

Related Teaching Methods

[view all >](#)

Modeling Instruction

Instruction organized around active
student construction of conceptual and

Examples

Resources



Research



Translations

Variations

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**.



Examples

Resources



Research



Translations

Variations

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



Force Concept Inventory (FCI)

developed by David Hestenes, Malcolm Wells, and Gregg Swackhamer

<http://modelinginstruction.org/researchers/evaluation-instruments/>

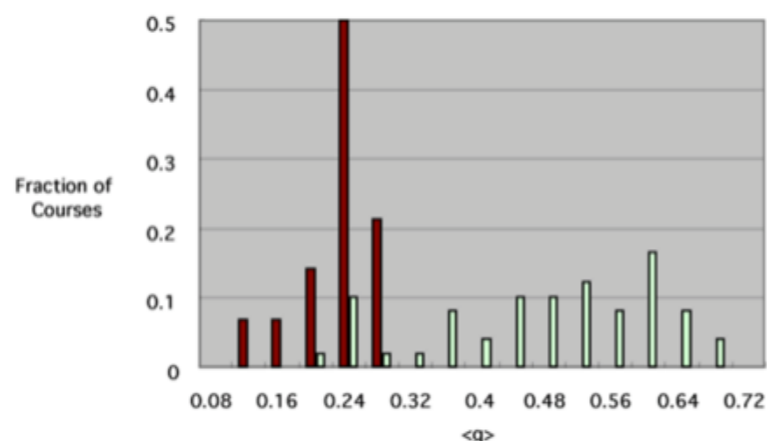
Multiple-choice, Pre/post

Duration 30 minutes

Focus Mechanics Content Knowledge (Kinematics, Forces)

Level Introductory

Typical Results



Explore More Results



Examples

Resources



Research



Translations

Variations

RESEARCH VALIDATION

Gold Star Validation

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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

Related Expert

[view all >](#)

Recomendations

[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 \(FMCE\)](#)

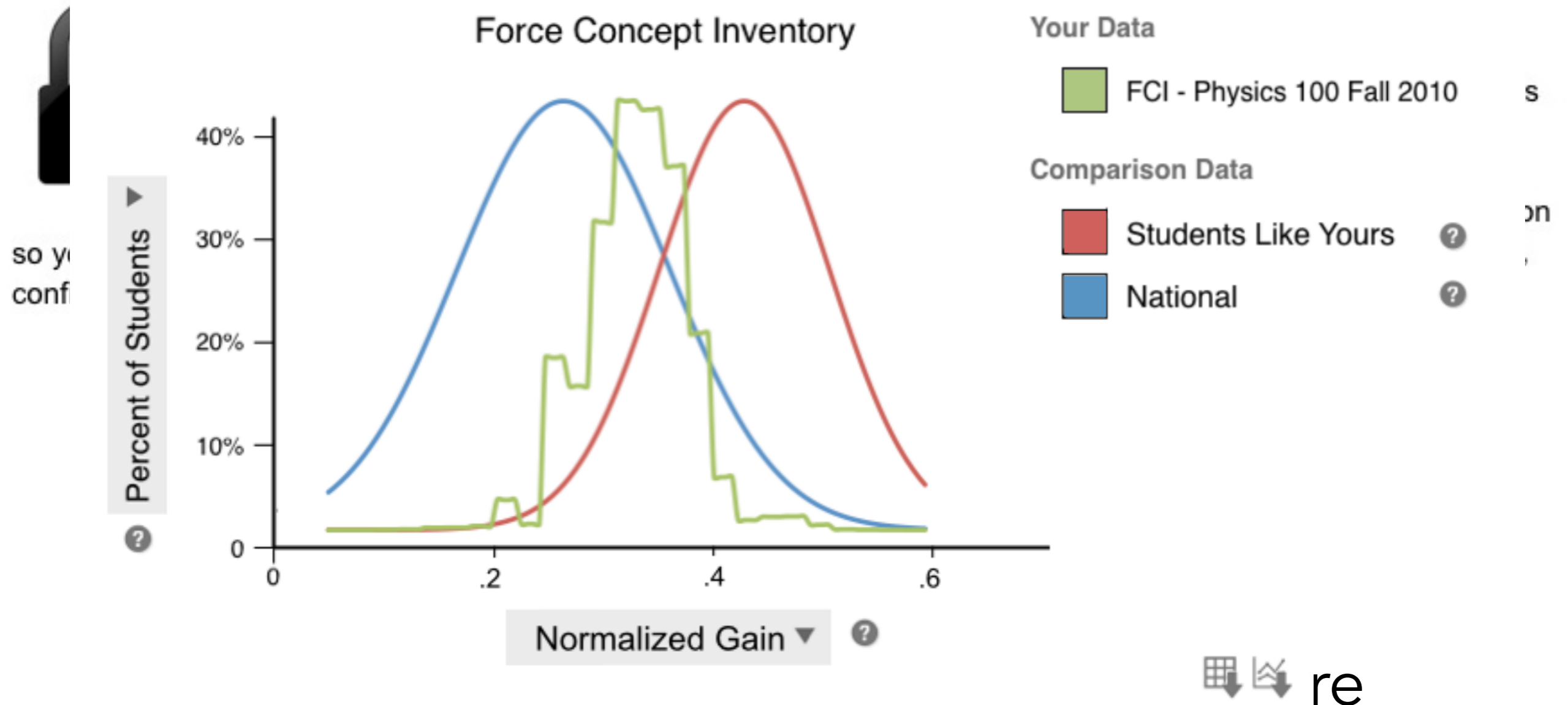
Related Teaching Methods

[view all >](#)

Modeling Instruction

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

Visualize and Analyze Your Assessment Data



transformations

- We report on aggregate data

Visualize and Analyze Your Results

Histogram For

Your Course

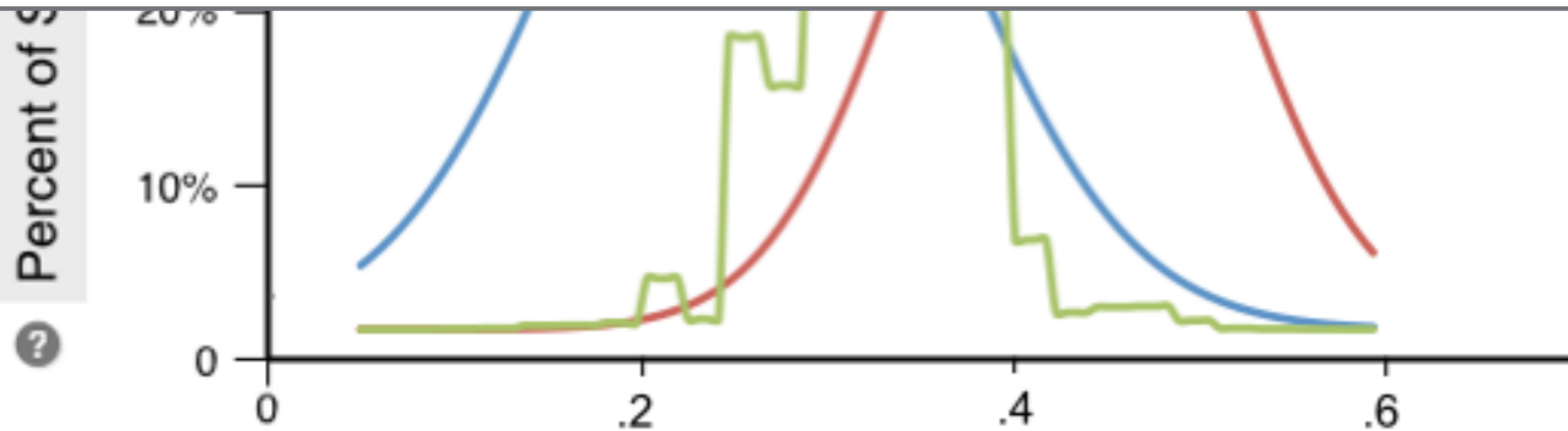
Breakdown By

Compare



Raphael the
Motivated
Novice

- 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

Split

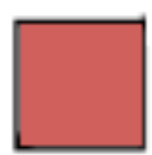
By

Compare Multiple Courses



FCI - Physics 100 Fall 2010

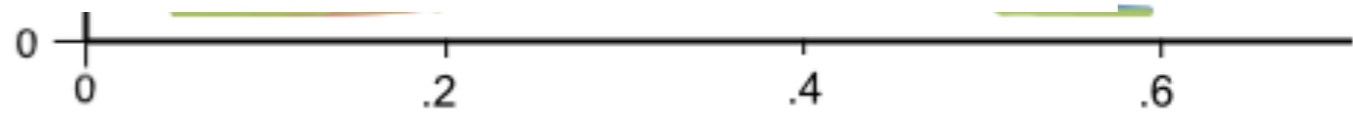
Comparison Data



Students Like Yours



National



Normalized Gain ▼



Summary

0.3

Average Gain

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 Data

 FCI - Physics 100 Fall 2

Comparison Data

 Students Like Yours

 National

Compare
Multiple Courses



Your Results Over Time

Your Data

Group | Split

Histogram For
Your Class

Your Course
Over Time

Breakdown By
Question

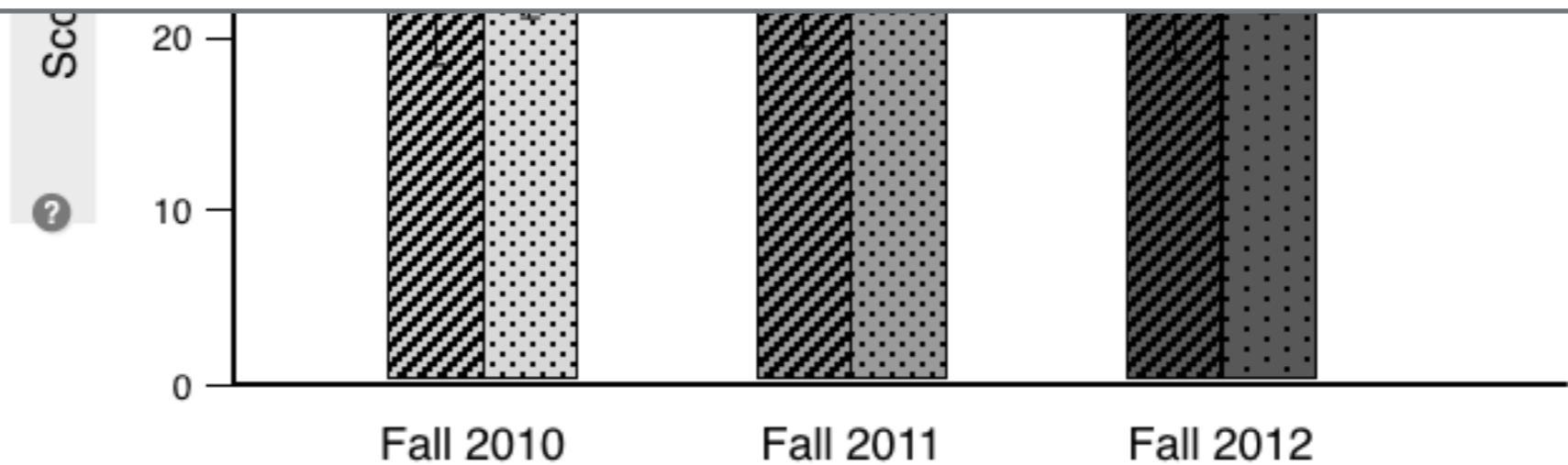
Compare
Multiple Courses

FCI - Physics 100 Fall 2010



**Diane the
Pragmatic
Satisficer**


- How do my results change over time?





Your Results Over Time

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 

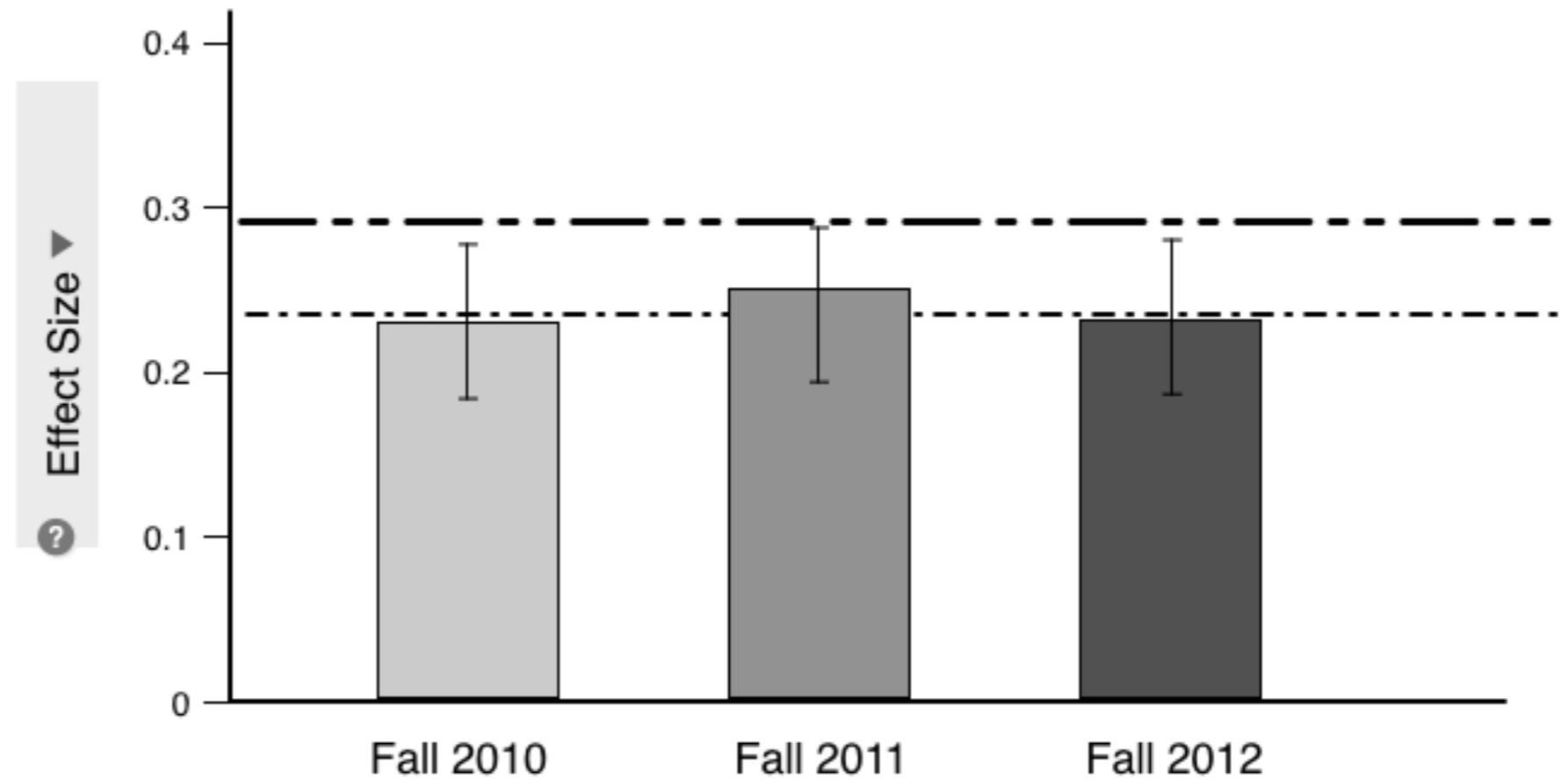
**Histogram For
Your Class**

**Your Course
Over Time**

**Breakdown By
Question**

**Compare
Multiple Courses**

Force Concept Inventory



Question-by-Question Breakdown

Histogram For

Your Course

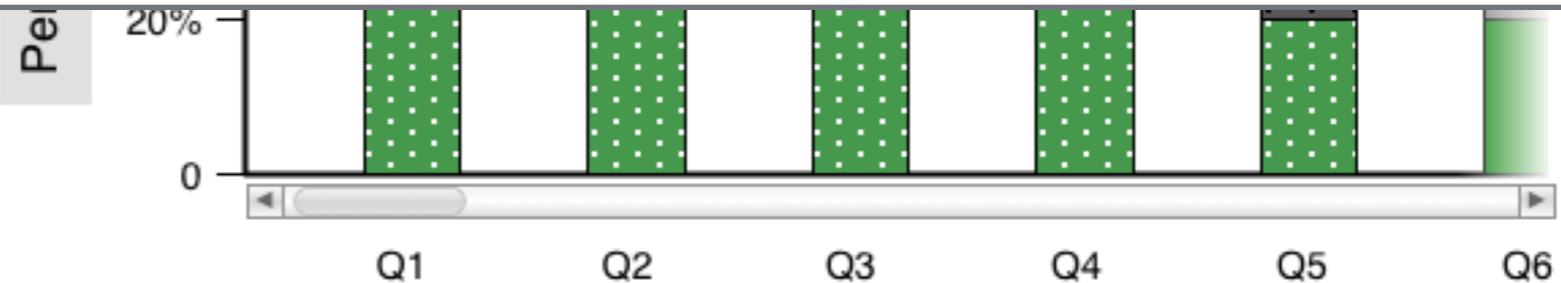
Breakdown By

Compare



Diane the
Pragmatic
Satisficer

- 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?



By Question ▼



Question-by-Question Breakdown

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

Your Data Split

FCI - Physics 100 Fall 2010

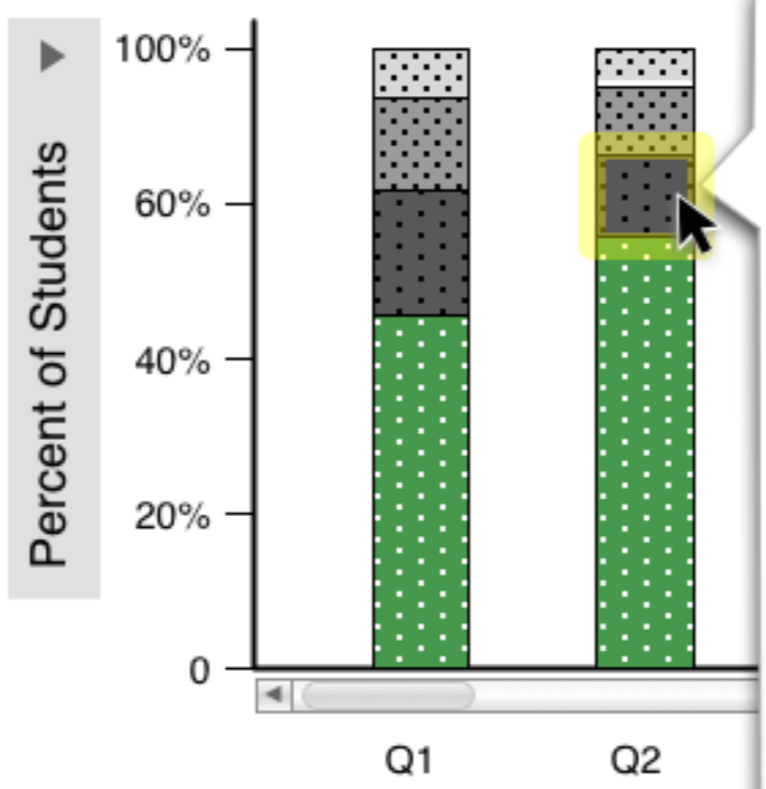
Comparison Data

Students Like Yours ?

National Median ?

Pre Post

Force Concept Inventory



Question 2

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	10%
(B) 1 and 2	15%
(C) 1, 2, and 3	40%
(D) 1, 2, and 4	30%
(E) none of these, since the book is at rest there are no forces acting on it.	5%


By Question ▼



Question-by-Question Breakdown

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

Your Data Split

 FCI - Physics 100 Fall 2010

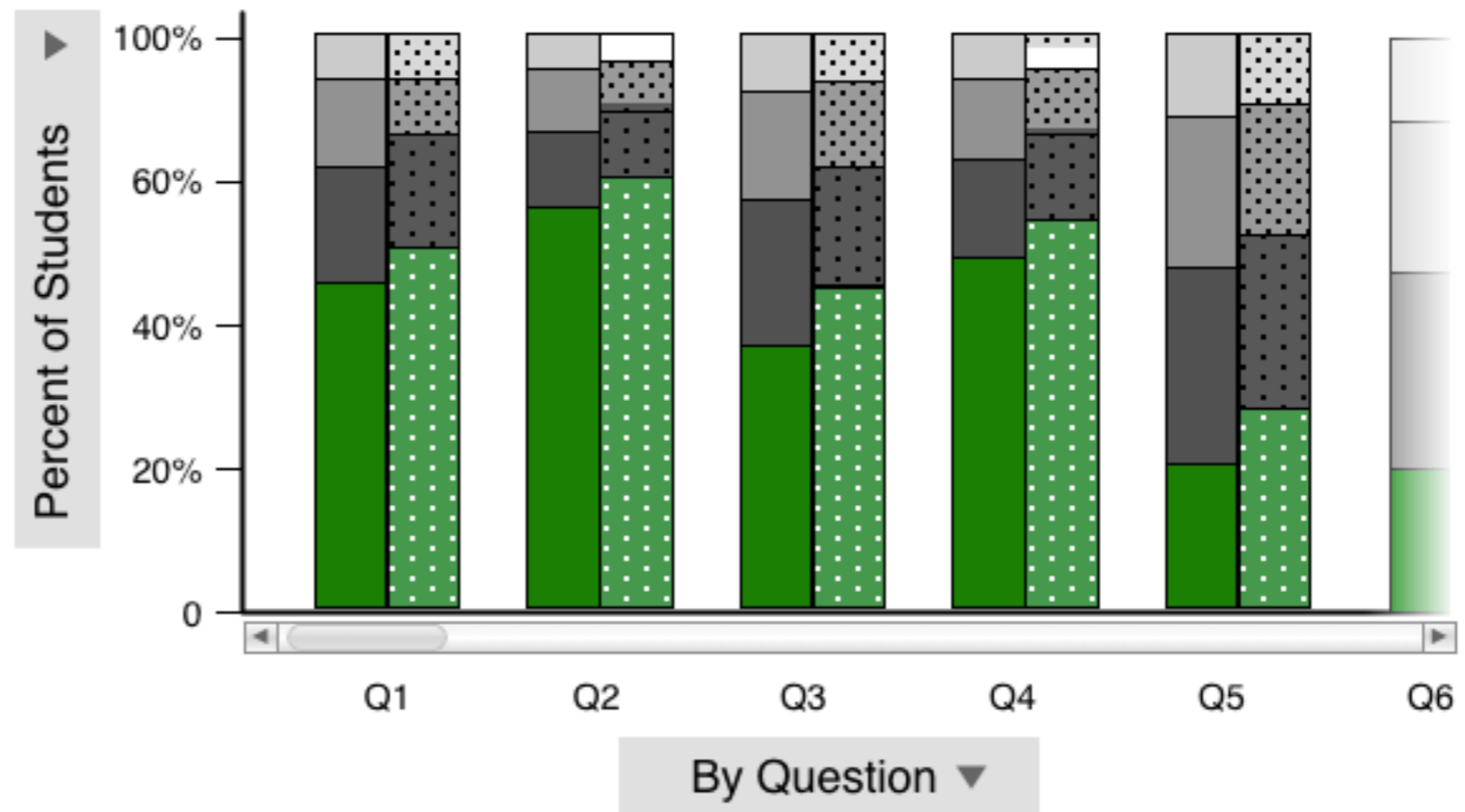
Comparison Data

 Students Like Yours ?

 National Median ?

Force Concept Inventory

Pre  Post 



Question-by-Question Breakdown

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

Your Data Split

FCI - Physics 100 Fall 2010

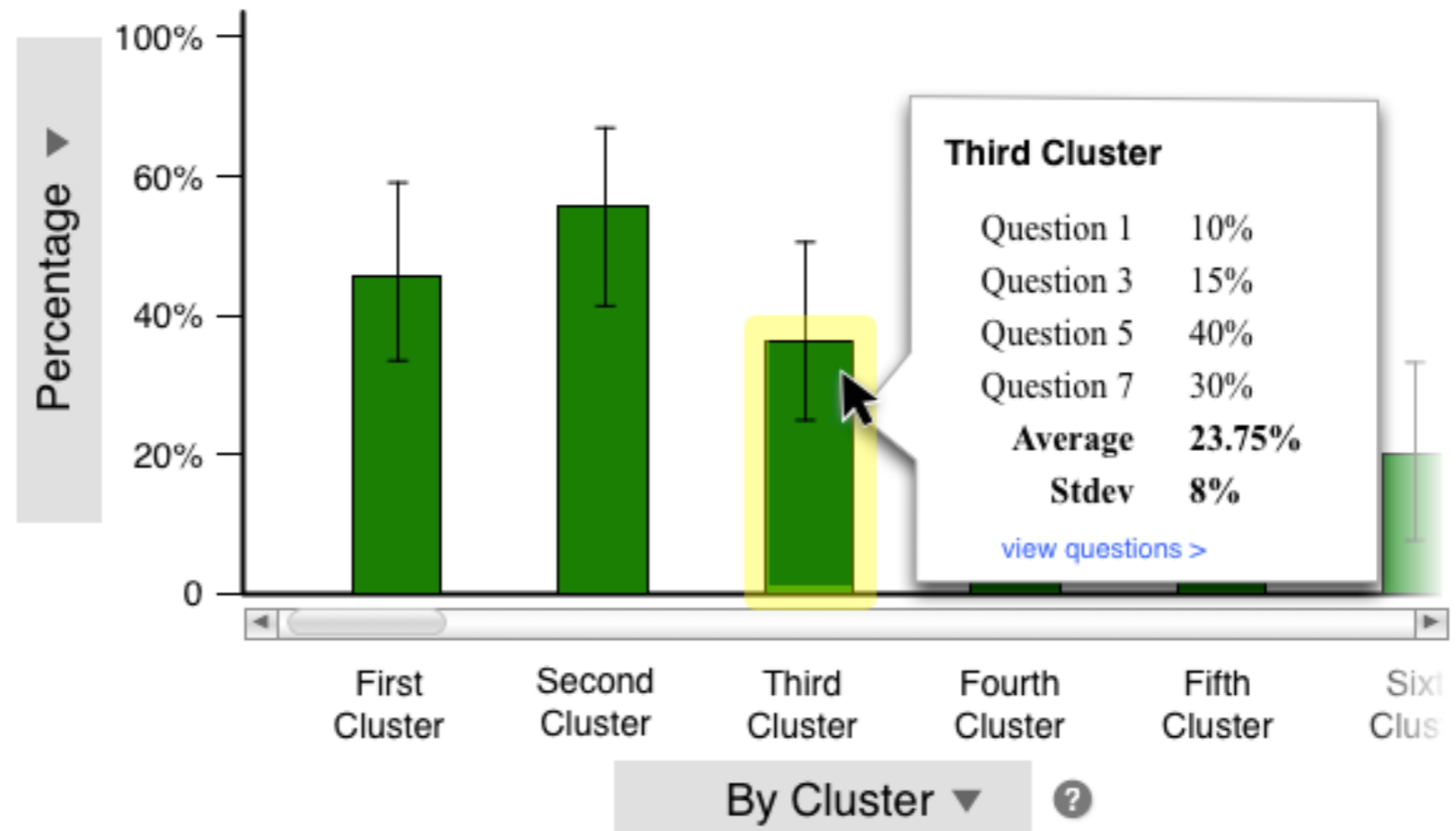
Comparison Data

Students Like Yours ?

National Median ?

Force Concept Inventory

Pre Post



Compare Multiple Courses

Histogram For

Your Course

Breakdown By



Compare





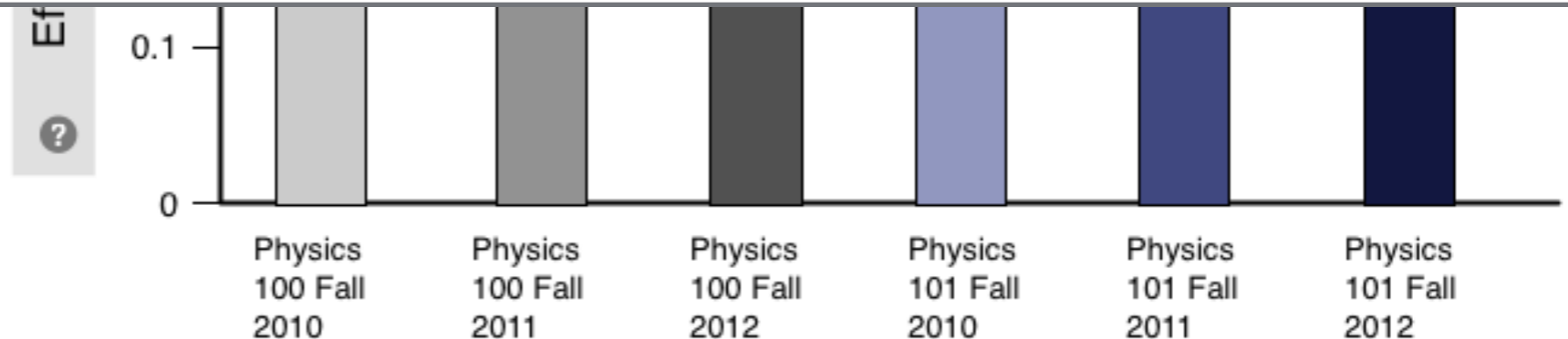
Tim the Seeker

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

Comparison Data

 Students Like Yours 

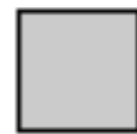
 National Average 



Co

Your Data

Group | Split



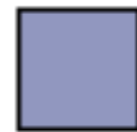
FCI - Physics 100 Fall 2010
[Add Post Data](#)



FCI - Physics 100 Fall 2011



FCI - Physics 100 Fall 2012



FCI - Physics 101 Fall 2010



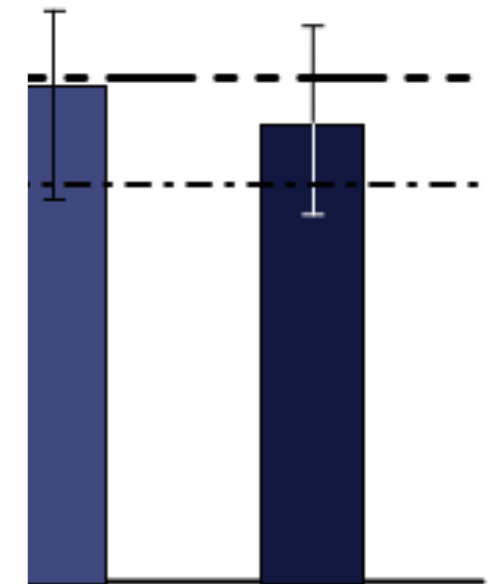
FCI - Physics 101 Fall 2011



FCI - Physics 101 Fall 2012



Compare
Multiple Courses



Physics
101 Fall
2011

Physics
101 Fall
2012



Comparison Data



Students Like Yours



National Average



Compare Multiple Courses

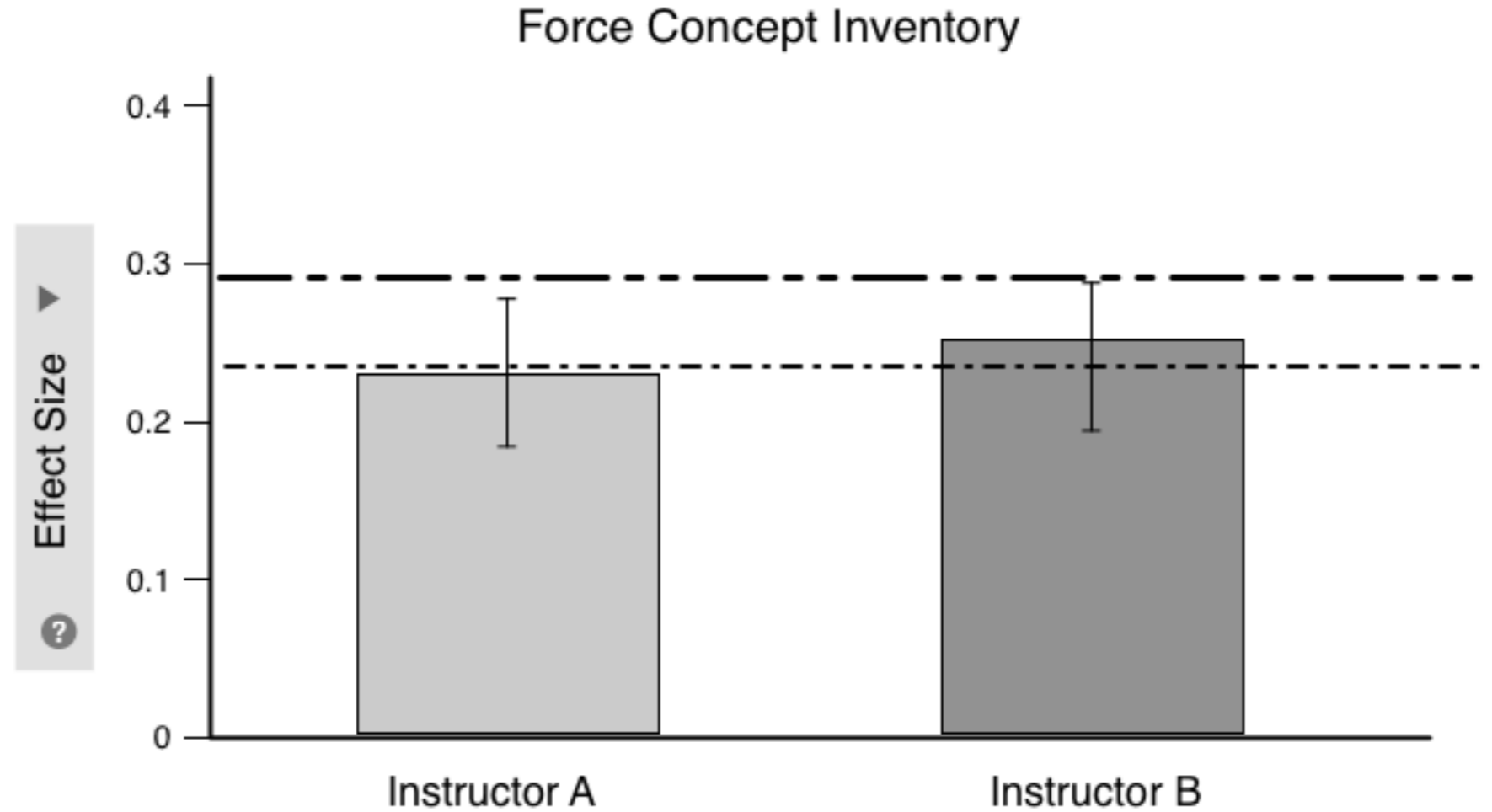
Histogram For Your Class **Your Course Over Time** **Breakdown By Question** **Compare Multiple Courses**

Your Data [Group](#) | [Split](#)

- FCI - Physics 100 Fall 2010 [Add Post Data](#)
- FCI - Physics 100 Fall 2011
- FCI - Physics 100 Fall 2012
- FCI - Physics 101 Fall 2010
- FCI - Physics 101 Fall 2011
- FCI - Physics 101 Fall 2012

Comparison Data

- Students Like Yours [?](#)
- National Average [?](#)



Compare Multiple Courses

[Histogram For Your Class](#)
[Your Course Over Time](#)
[Breakdown By Question](#)
[Compare Multiple Courses](#)

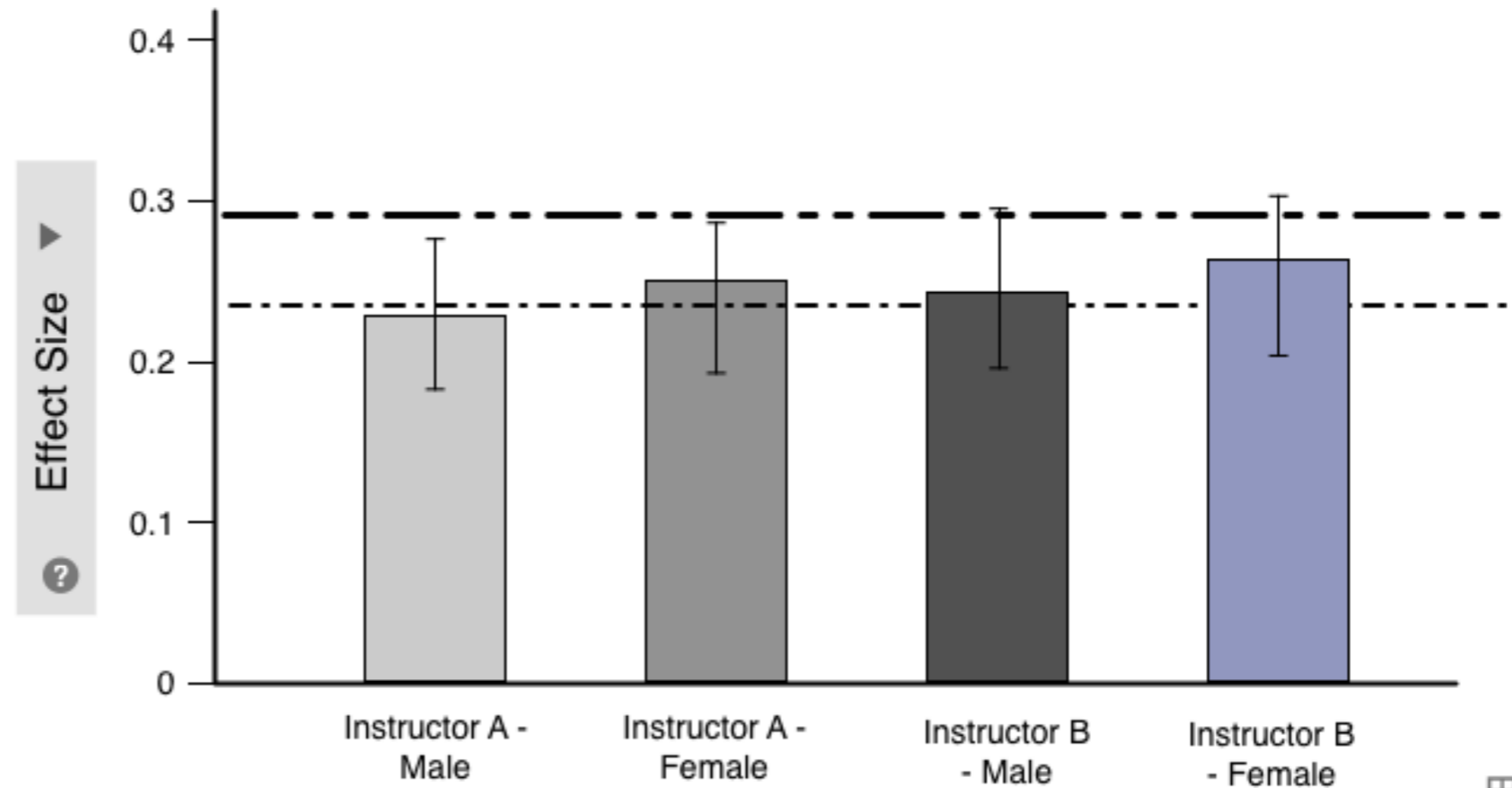
Your Data [Group](#) | [Split](#)

- FCI - Physics 100 Fall 2010 [Add Post Data](#)
- FCI - Physics 100 Fall 2011
- FCI - Physics 100 Fall 2012
- FCI - Physics 101 Fall 2010
- FCI - Physics 101 Fall 2011
- FCI - Physics 101 Fall 2012

Comparison Data

- Students Like Yours ?
- National Average ?

Force Concept Inventory



Upload Assessment Results

U
A
R
V



**Raphael the
Motivated
Novice**




**Diane the
Pragmatic
Satisficer**

- When will I find the time to analyze my data?

Add Metadata

Physics 101.xml: fall2013 section 2

School


Instructor

Course

Class

Assessment

Add Metadata

Course Details ✕

Required to Visualize Your Class Data

Course Name: *

Course ID: *

Course Level: ▼ *

Analyze and Compare Data With Others Nationwide

Course Length: ##
weeks

Hours per week:

Help Improve Physics Education Worldwide

Prerequisite courses: ▼ +

Prerequisite math courses: ▼ +

* required field

Add Metadata

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

Status: Saved



Required to Visualize
Your Class Data

Semester/term class was taught:

Semester * Spring * Year *

Analyze and Compare
Data With Others
Nationwide

Style of instruction:

text

Instructional Practices:

Instructor lectures



Instructor lead whole class discussion



Students work together in small groups



Students work individually



Students present to the whole class



Other



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

Please describe

Hours/week taught by primary instructor:

text

Experience teaching this course:

years

OK

Cancel

Add Metadata

Physics 101.xml: fall2013 section 2

School

University of Central Flatland



Instructor

Dr. Username



Course

Phys 100



Class

Spring 2013













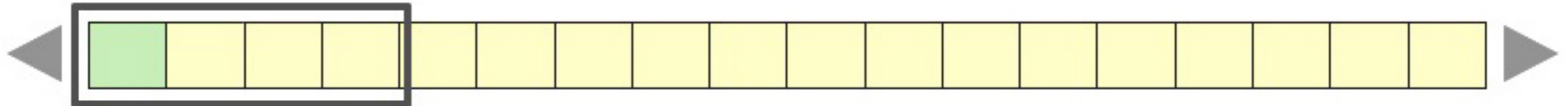
Assessment

FCI Pre and Post











Confirm Auto Guesses in Your File









A	B	C	D
 Student ID ▼	 TOEFL Score  	 FCI Q1  	 FCI Q2  
ID Number	Course Grade	Q1	Q2
252654	75	B	B
652365	80	C	G
652365	95	D	D

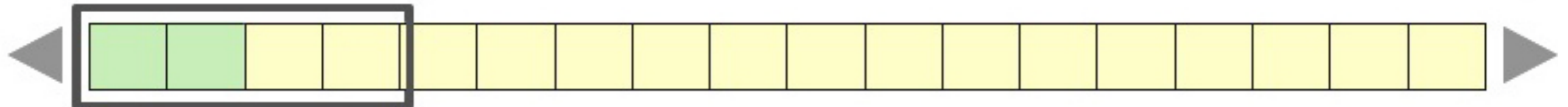


Confirm Auto Guesses in Your File

A	B	C	D
 Student ID ▼	 TOEFL Score ▼	 FCI Q1  	 FCI Q2  
ID Number	Course Grade	Assessment Data	Q2
252654	75	FCI Pre Question 1	B
652365	80	FCI Pre Score	G
652365	95	FCI Pre Other >	D
		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	

Confirm Auto Guesses in Your File

A	B	C	D
 Student ID	 Course Grade ▼	 FCI Q1  	 FCI Q2  
ID Number	Course Grade	Q1	Q2
252654	75	B	B
652365	80	C	G
652365	95	D	D



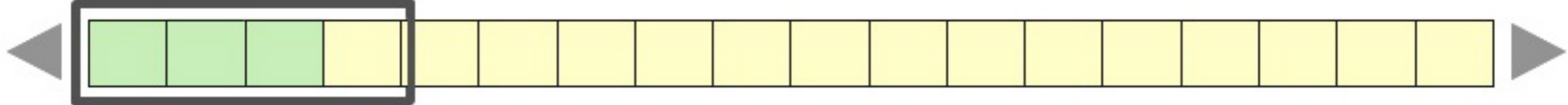


It looks like Column B - AD are FCI Questions 2-30

Confirm columns B - AD?



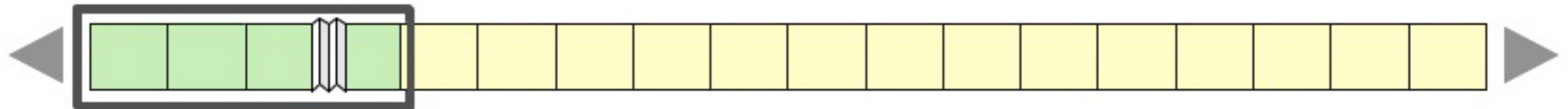
A	B		
Student ID	Course Grade ▼	FCI Q1 ▼	
ID Number	Course Grade	Q1	Q2
252654	75	B	B
652365	80	C	G
652365	95	D	D



Add Metadata

Tell us about the file you uploaded

A	B	C	+	AF
✓ Student ID	✓ Course Grade ▼	✓ FCI Q1 ▼		✓ FCI Q30 ▼
ID Number	Course Grade	Q1		Q2
252654	75	B		B
652365	80	C		G
652365	95	D		D



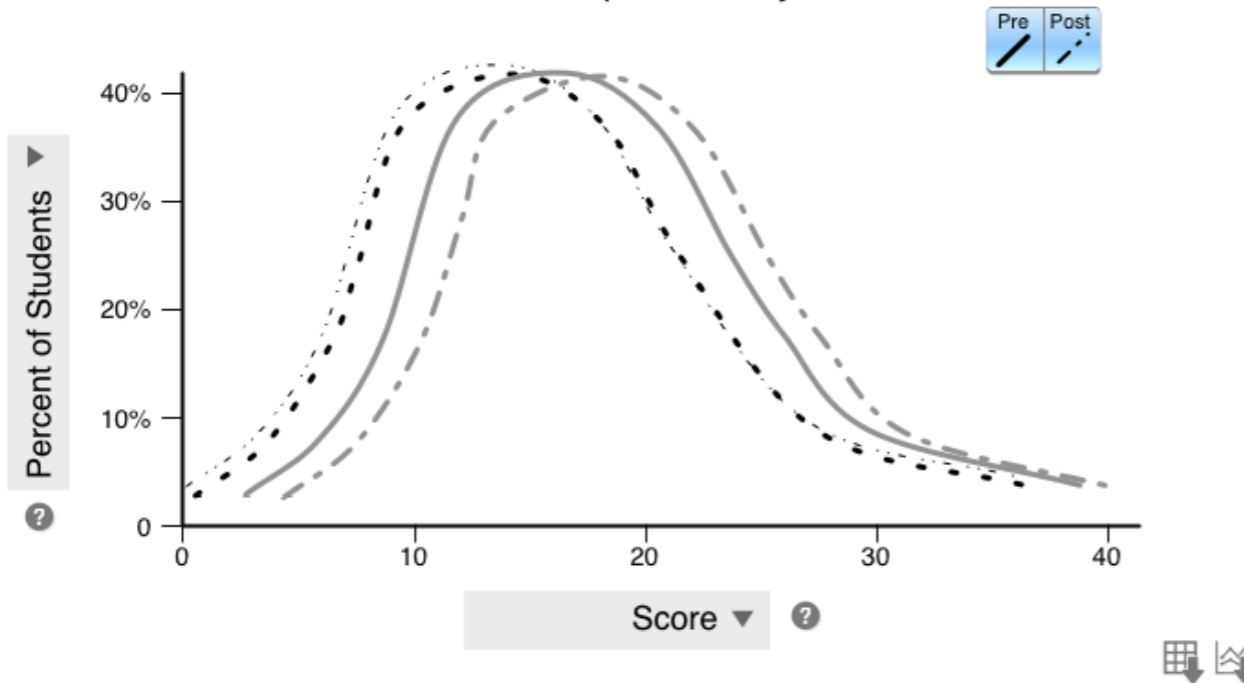
Done

Download Your Report

FCI Results

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

Force Concept Inventory



Summary

0.3

Average Gain

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.

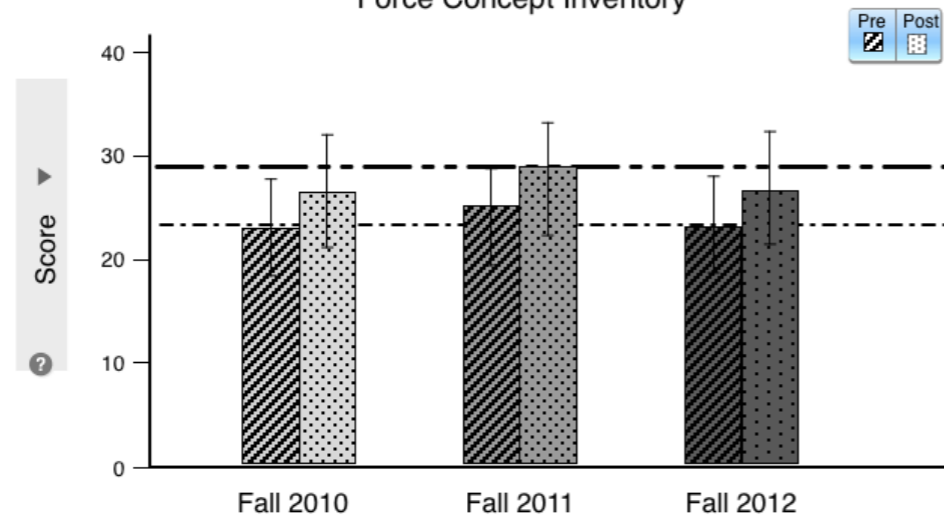
Courses taught using interactive engagement techniques have gains in the range from .18 to .66 with an average of .48. Your normalized gain is in the lower end of this range.

Recommendations

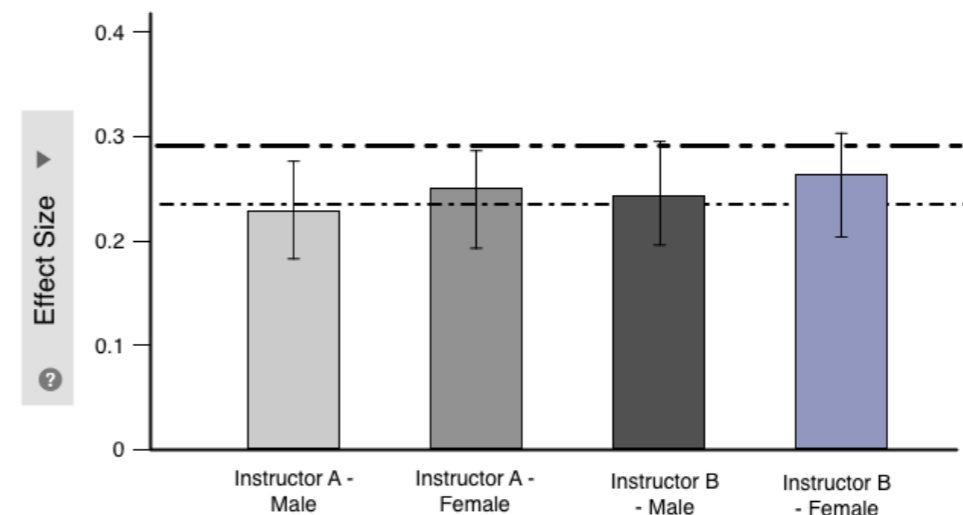
Large courses like yours that are taught using interactive engagement techniques tend to have higher normalized gains. The key to these methods is getting students actively engaged in constructing their own understanding and not just passively listening.

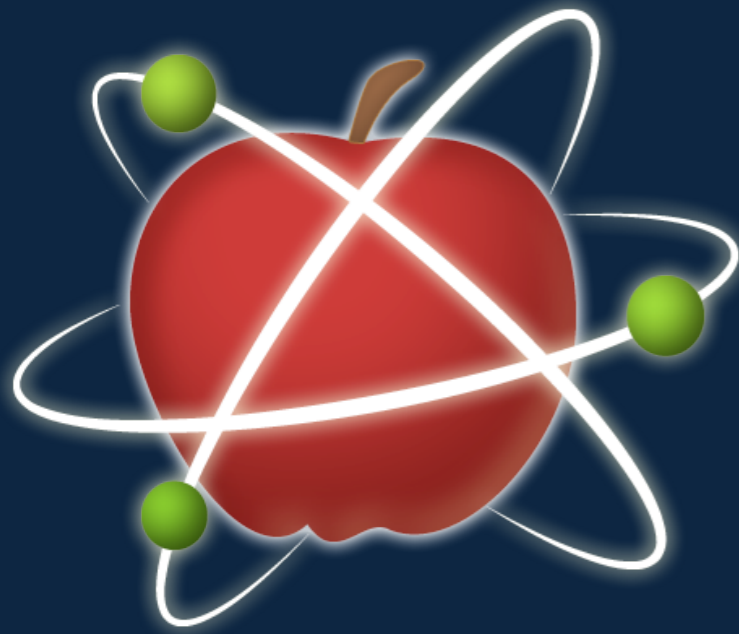
This can be accomplished in many ways. Popular methods that you could try include: [Peer Instruction](#), [Phet Simulations](#), [Interactive Lecture Demos](#) and [Just In Time Teaching](#).

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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:
[zapos.com/home2/assessment-
for-faculty](http://zapos.com/home2/assessment-for-faculty)

