PHYSPORT AND ASSESSMENT

Deonna Woolard

Randolph-Macon College

CS-AAPT 2018 Spring Meeting

CURRENT R-MC ASSESSMENT PRACTICES

- **Force Concept Inventory (FCI) in Intro Physics I**
  - Our majors – Physics, Engineering Physics, Astrophysics
  - Chemistry
  - Pre-Med (Biology)
  - General Education
- **Technical Writing Ability for Seniors**
- **Alumni Outcomes**

Force Concept Inventory (FCI)

Developed by David Hestenes, Malcolm Wells, Gregg Swackhamer, Ibrahim Halloun, Richard Hake, and Eugene Mosca

Download

Purpose To assess students' understanding of the most basic concepts in Newtonian physics using everyday language and common-sense distractors.

Format Pre/post, Multiple-choice

Duration 30 min

Focus Mechanics Content knowledge (forces, kinematics)

Level Intro college, High school

Examples | Resources | Scoring | Research | Translations | Versions

Sample question from the FCI:

A stone dropped from the roof of a single story building to the surface of the earth:

(A) reaches a maximum speed quite soon after release and then falls at a constant speed thereafter.

(B) speeds up as it falls because the gravitational attraction gets considerably stronger as the stone gets closer to the earth.

(C) speeds up because of an almost constant force of gravity acting upon it.

(D) falls because of the natural tendency of all objects to rest on the surface of the earth.

(E) falls because of the combined effects of the force of gravity pushing it downward and the force of the air pushing it downward.

Variations

Representational Variant of the Force Concept Inventory
Content knowledge Mechanics (multiple representations, kinematics, forces, graphing)
High school
Pre/post, Multiple-choice

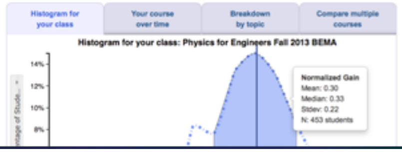
Mechanics Baseline Test
Content knowledge Mechanics (kinematics, forces, momentum, energy)
Intro college, High school
Multiple-choice

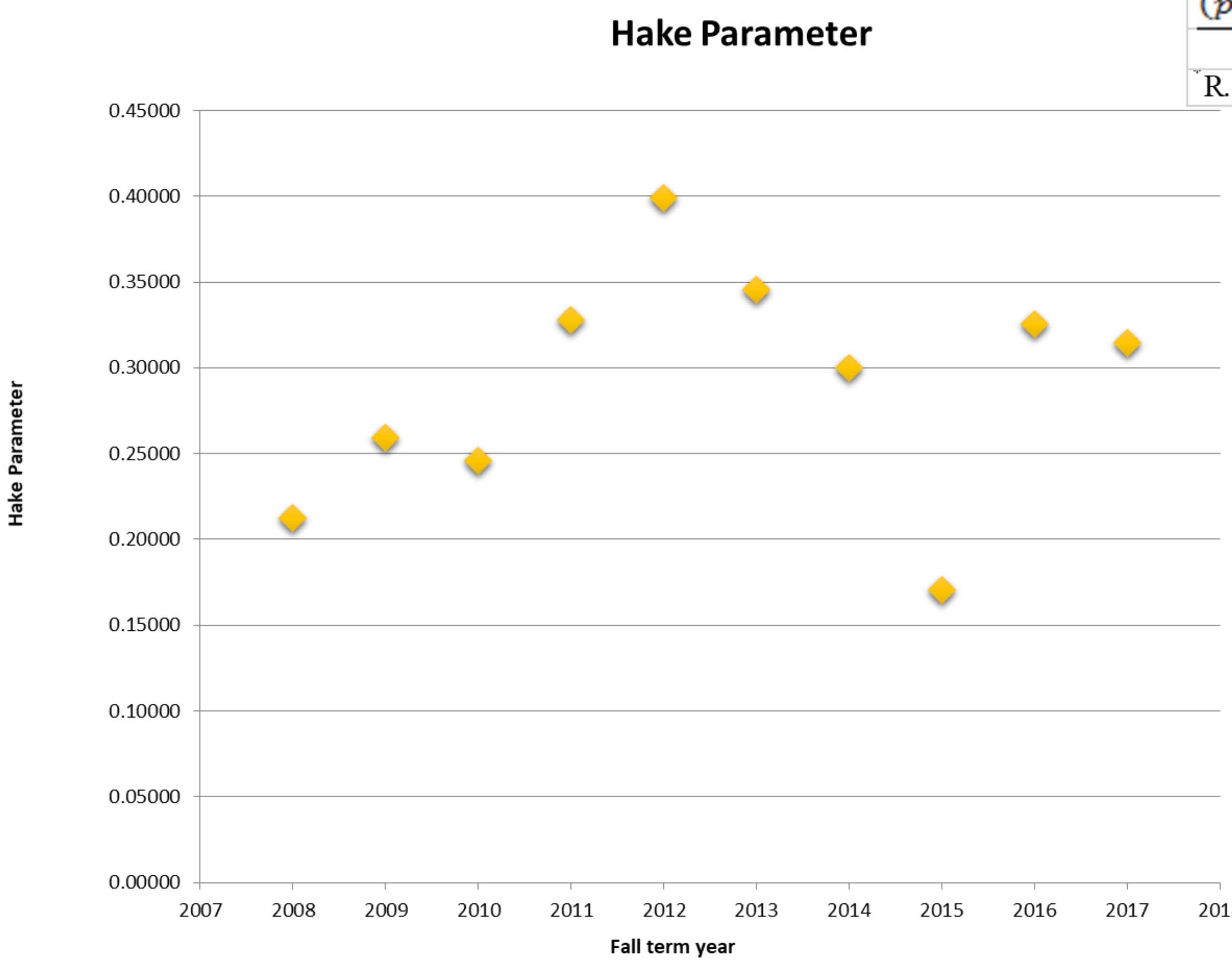
Simplified Force Concept Inventory
Content knowledge Mechanics (kinematics, forces)
High school, Middle school
Multiple-choice

Related Teaching Method

Modeling Instruction

NEW - PhysPort Data Explorer





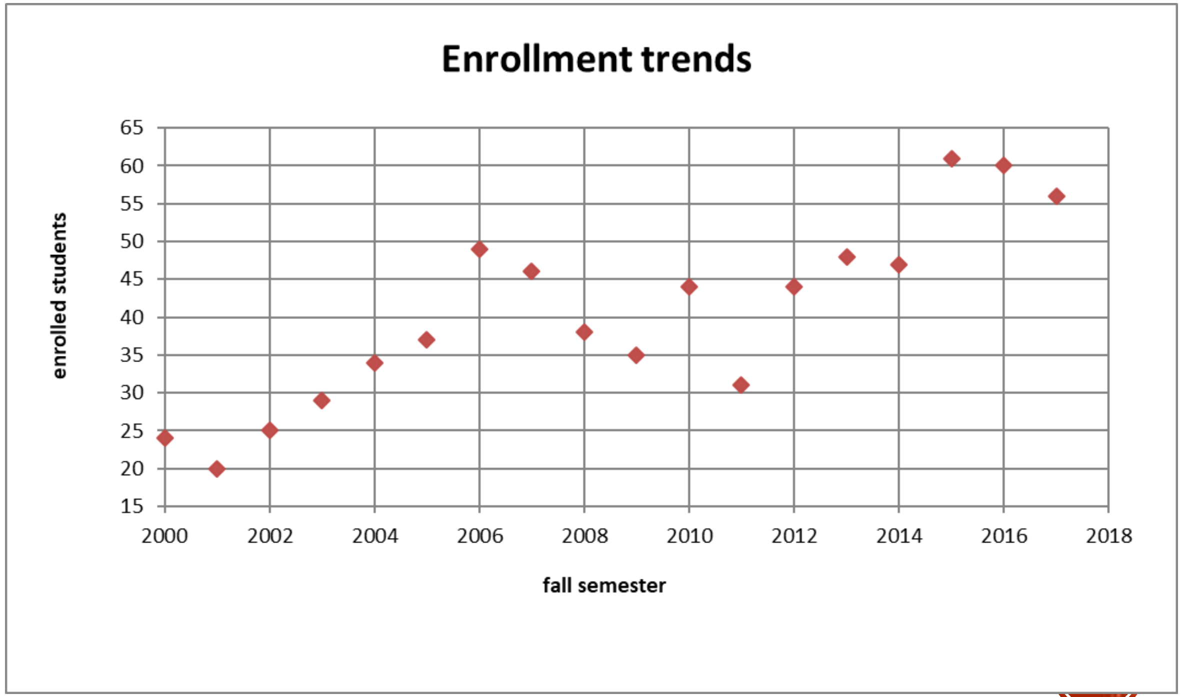
*The Hake parameter** *is defined as*

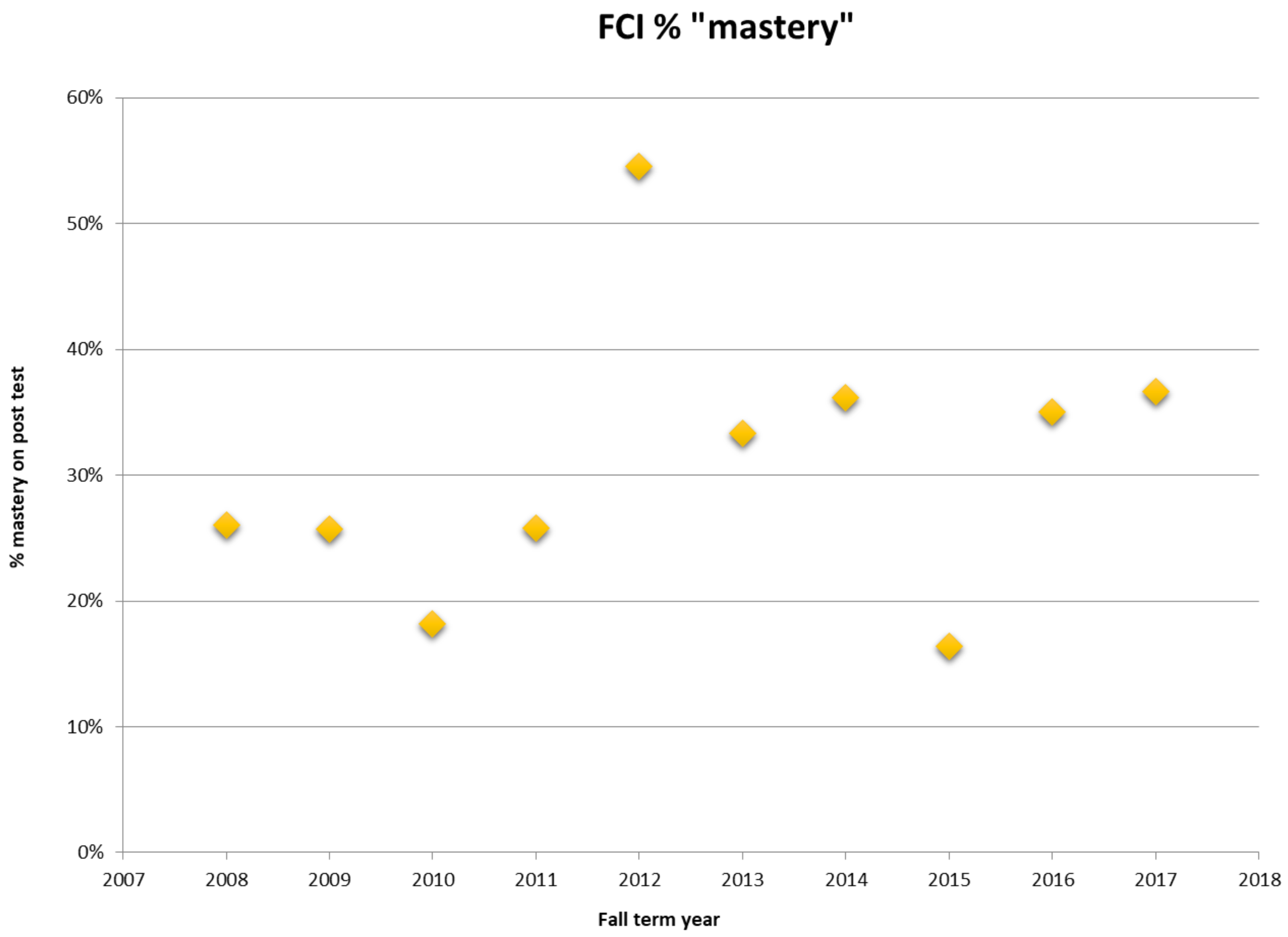
$$\frac{(posttest\ average - pretest\ average)}{(100 - pretest\ average)}$$

*R. R. Hake, *Am. J. Physics*, **66**:1, 64-74 (1998)

Von Korff et al "Secondary analysis of teaching methods in introductory physics: A 50 k-student study," *American Journal of Physics*, **84**, 969 (2016)

the average normalized gain (Hake Parameter) is **0.39** for interactive engagement courses and **0.22** for traditional lecture courses.





Mastery > 17 correct


Pre vs Post-Test Mastery Level
2017
2016
2015
2014
2013
2012
19
3
22
16
5
21
6
4
10
12
6
18
12
4
16
19
5
24
0
5
10
15
20
25
30
Post - Pre
Pre-Test
Post-Test

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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

How do I help students engage productively in active learning classrooms?

by Stephanie Chasteen, University of Colorado Boulder — June 20, 2017

If you incorporate active-learning strategies into your teaching, you may find that students don't automatically embrace this new learning approach. What are research-based recommendations for motivating students to engage? This is the introduction to a series of recommendations discussing strategies to support student engagement. INTRODUCTION.

engagement, active learning, productive engagement

Read more »

What racial, gender, and sexual orientation bias still exists in physics and what can I do about it?

by Ramón S. Barthelemy — February 10, 2016

As physicists we often believe that our field is a place where anyone can succeed regardless of race, gender, or sexual orientation. Although overt discrimination has decreased, many kinds of unintentional and intentional bias still run rampant. Fortunately, many of these biases are identifiable and there are actionable steps your department can take to prevent and address...

equity

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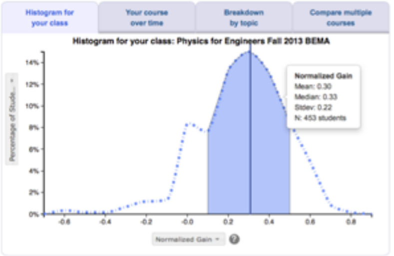

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- **Assessment Guides** to over 50 research-based assessment instruments that you can use to find out what your students are learning evaluate the effectiveness of your teaching. Verified educators can download most assessments directly from our site.
- **Assessment Data Explorer** where you can get instant analysis of your students' scores on research-based assessment instruments, comparisons to national averages and students like yours, recommendations for improving your teaching, and reports for tenure and promotion files, teaching portfolios, and departmental accreditation. (sign up to be a beta tester now!)
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Our goal is to empower physics faculty to use effective research-based teaching so that every student has the opportunity to learn physics.

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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

87 Research-Based Assessments

Sort by: Subject

Content knowledge

Force Concept Inventory (FCI)
Mechanics Content knowledge (forces, kinematics)
Levels: Intro college, High school
Formats: Pre/post, Multiple-choice
30 min

Force and Motion Conceptual Evaluation (FMCE)
Mechanics Content knowledge (kinematics, forces, energy, graphing)
Levels: Intro college, High school
Formats: Pre/post, Multiple-choice
35 min

Test of Understanding Graphs in Kinematics (TUG-K)
Mechanics Content knowledge (kinematics, graphing)
Levels: Intro college, High school
Formats: Pre/post, Multiple-choice
45 min

Energy and Momentum Conceptual Survey (EMCS)

PHYS 151 Pre Test

This is a preview of the published version of the quiz

Started: Apr 25 at 4:41pm

Quiz Instructions

Select the best answer to the following questions.

Question 1 — 1 pts

Two metal balls are the same size but one weighs twice as much as the other. The balls are dropped from the roof of a single story building at the same instant of time. The time it takes the balls to reach the ground below will be:

- ○ about half as long for the heavier ball as for the ligher one
- ○ about half as long for the ligher ball as for the heavier one
- ○ about the same for both balls
- ○ considerably less for the heavier ball, but not necessarily half as long
- ○ considerably less for the ligher ball, but not necessarily half as long

Next ▸

Not saved Submit Quiz

Keep Editing This Quiz

Questions
Question 1
Question 2
Question 3
Question 4
Question 5
Question 6
Question 7
Question 8

Time Elapsed: Hide
0 Minutes, 17 Seconds

Question Breakdown

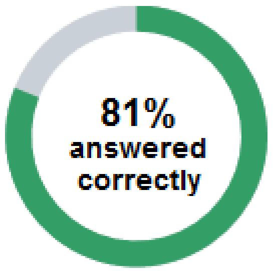
Attempts: 58 out of 58

+0.26

Discrimination Index

Two metal balls are the same size but one weighs twice as much as the other. The balls are dropped from the roof of a single story building at the same instant of time. The time it takes the balls to reach the ground below will be:

about half as long for the heavier ball as the for the ligher one	5 respondents	9 %
about half as long for the ligher ball as for the heavier one	3 respondents	5 %
about the same for both balls ✔	47 respondents	81 %
considerably less for the heavier ball, but not necessarily half as long	3 respondents	5 %
considerably less for the ligher ball, but not necessarily half as long		0 %



Data Explorer beta
by PhysPort

Deonna Woolard
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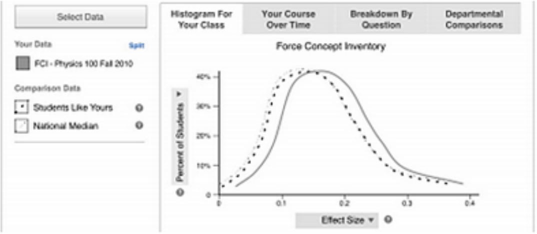

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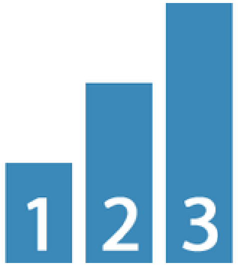

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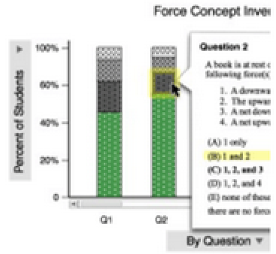
*not all assessments have clusters **you must upload data for each course to be compared



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by Stephanie Chasteen, University of Colorado Boulder — June 20, 2017

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engagement, active learning, productive engagement — Read more »

Where can I find good activities for small group discussions?

by Sam McKagan, PhysPort director — September 26, 2016

Nearly all research-based teaching methods in physics involve some kind of small group discussions of challenging conceptual activities. Finding good activities is an important component of making small group discussions work in your class. This recommendation includes links to collections where you can find activities to use in your class.

active learning, SCALE-UP, Peer Instruction, CAE Think-Pair-Share, Technology-Enhanced Formative Assessment, clickers, cooperative groups — Read more »

What racial, gender, and sexual orientation bias still exists in physics and what can I do about it?

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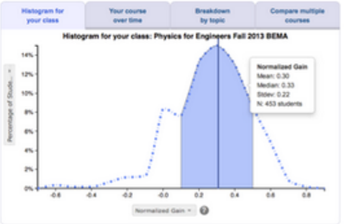

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Expert Recommendations

FEATURED

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

by Jenny Knight and Sarah Wise, University of Colorado - Boulder — March 15, 2016

Clicker questions are increasingly being used to stimulate student discussion and provide faculty and students with timely feedback. Research suggests that discussing clicker questions can lead to increased student learning, and that students exchanging constructive criticism can generate conceptual change.
What can you do as an instructor to encourage all students to have...
Read more »

clickers, cooperative groups, active learning, best practices, peer instruction

How do I help students engage productively in active learning classrooms?
by Stephanie Chasteen, University of Colorado Boulder

Where can I find good activities for small group discussions?
by Sam McKagan, PhysPort director

What racial, gender, and sexual orientation bias still exists in physics and what can I do about it?
by Ramón S. Barthelemy

RECENT

Best practices for whiteboarding in the physics classroom

by Sam McKagan and Daryl McPadden — September 22, 2017

Whiteboards are an indispensable tool that physicists use to work out ideas individually and collaboratively, and to present those ideas, both for public discussion and critique of tentative ideas and for communication of more fully formed ideas. In this recommendation, we offer guidance for how to use whiteboarding effectively in your classroom.
Read more »

whiteboarding, best practices, SCALE-UP, Modeling Instruction

What if I get low student evaluations, or hear complaints about active learning?

by Stephanie Chasteen, University of Colorado Boulder — June 20, 2017

Most Popular
- Normalized gain: What is it and when and how should I use it?
- How do I help students engage productively in active learning classrooms?
- Effect size: What is it and when and how should I use it?

View all »

Tags
active learning, assessment, best practices, cooperative groups, engagement, productive engagement

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Best Practices
- Normalized gain: What is it and when and how should I use it?
- Effect size: What is it and when and how should I use it?
- How can I get students to have productive discussions of clicker questions?
- Guidelines for administering concept inventories online

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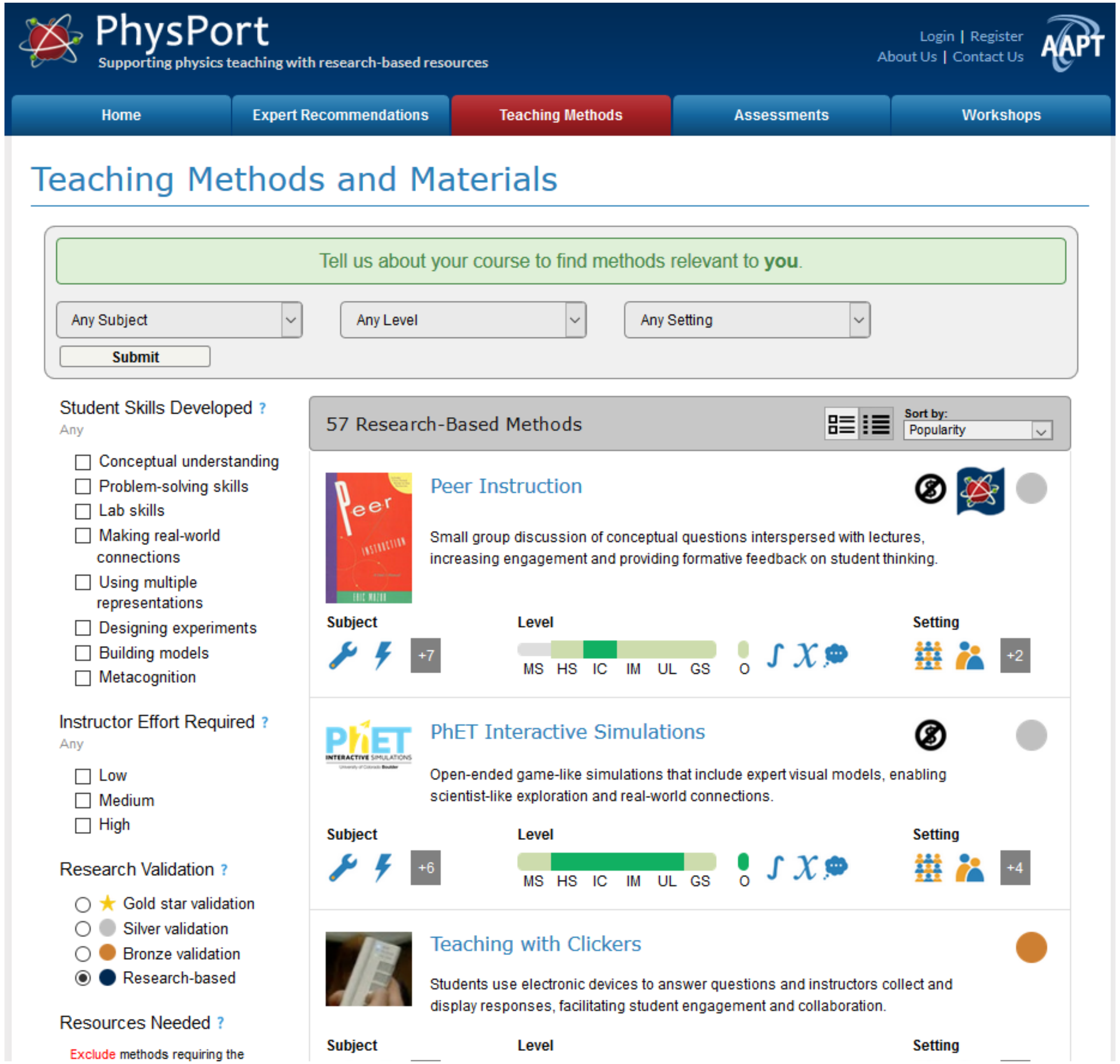
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Any Level
Any Setting
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Student Skills Developed ?
Any
Conceptual understanding
Problem-solving skills
Lab skills
Making real-world connections
Using multiple representations
Designing experiments
Building models
Metacognition
Instructor Effort Required ?
Any
Low
Medium
High
Research Validation ?
Gold star validation
Silver validation
Bronze validation
Research-based
Resources Needed ?
Exclude methods requiring the
57 Research-Based Methods
Sort by:
Popularity
Peer Instruction
Small group discussion of conceptual questions interspersed with lectures, increasing engagement and providing formative feedback on student thinking.
Subject
+7
Level
MS HS IC IM UL GS
O
Setting
+2
PhET Interactive Simulations
Open-ended game-like simulations that include expert visual models, enabling scientist-like exploration and real-world connections.
Subject
+6
Level
MS HS IC IM UL GS
O
Setting
+4
Teaching with Clickers
Students use electronic devices to answer questions and instructors collect and display responses, facilitating student engagement and collaboration.
Subject
Level
Setting


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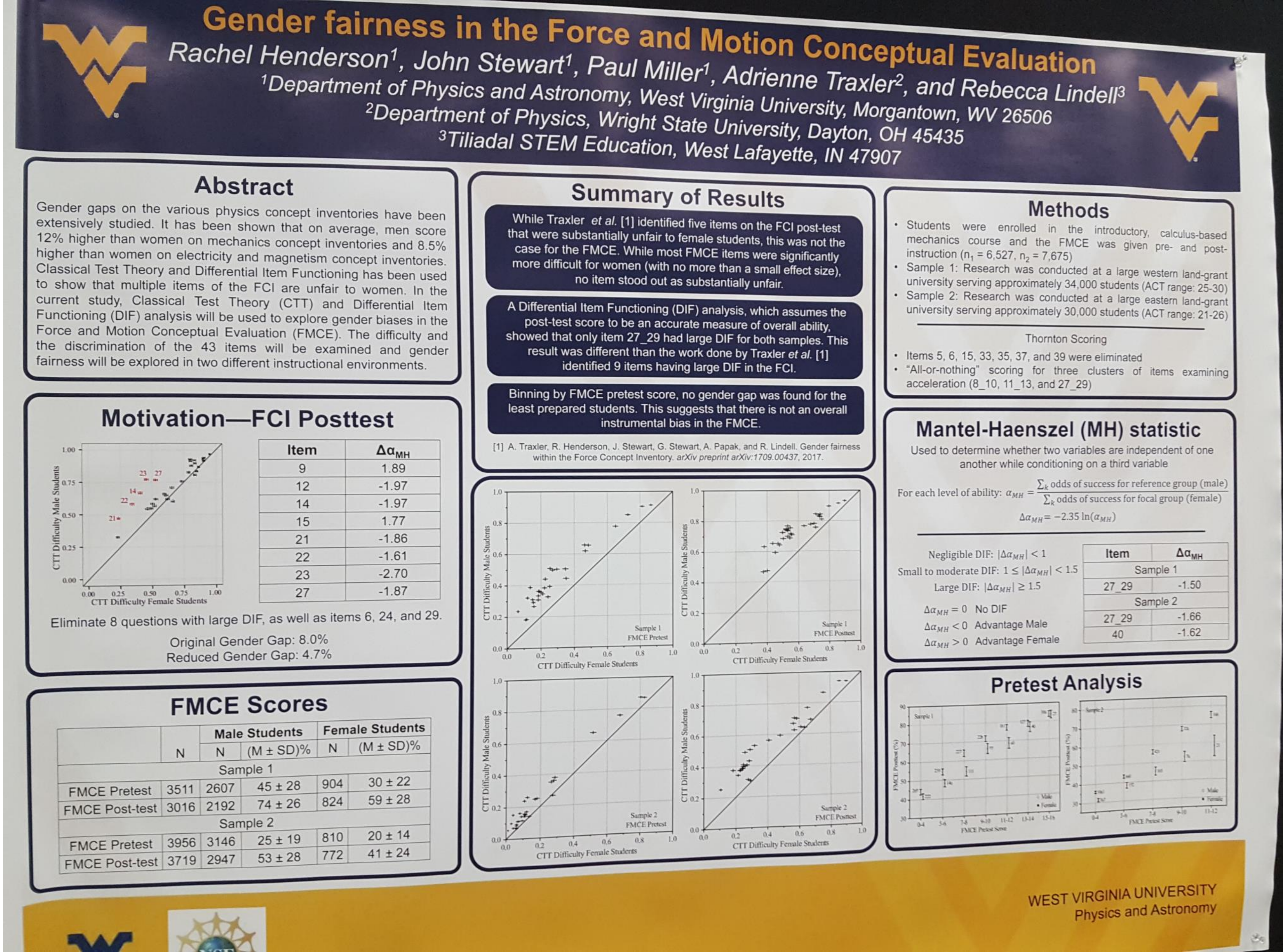
PhysPort features two collections of video workshops that you can use for:
• training teaching assistants (TAs) or learning assistants (LAs) to use best practices in teaching physics
• professional development for other faculty in instructional best practices
• learning to use research-based teaching in your own classes
What is 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
View Collection
New Faculty Workshop - Introduction
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
View Collection


Gender fairness in the Force and Motion Conceptual Evaluation
Rachel Henderson1, John Stewart1, Paul Miller1, Adrienne Traxler2, and Rebecca Lindell3
1Department of Physics and Astronomy, West Virginia University, Morgantown, WV 26506
2Department of Physics, Wright State University, Dayton, OH 45435
3Tiliadal STEM Education, West Lafayette, IN 47907
Abstract
Gender gaps on the various physics concept inventories have been extensively studied. It has been shown that on average, men score 12% higher than women on mechanics concept inventories and 8.5% higher than women on electricity and magnetism concept inventories. Classical Test Theory and Differential Item Functioning has been used to show that multiple items of the FCI are unfair to women. In the current study, Classical Test Theory (CTT) and Differential Item Functioning (DIF) analysis will be used to explore gender biases in the Force and Motion Conceptual Evaluation (FMCE). The difficulty and the discrimination of the 43 items will be examined and gender fairness will be explored in two different instructional environments.
Motivation—FCI Posttest
CTT Difficulty Male Students
CTT Difficulty Female Students
Item ΔαMH
9 1.89
12 -1.97
14 -1.97
15 1.77
21 -1.86
22 -1.61
23 -2.70
27 -1.87
Eliminate 8 questions with large DIF, as well as items 6, 24, and 29.
Original Gender Gap: 8.0%
Reduced Gender Gap: 4.7%
FMCE Scores
Male Students Female Students
N N (M ± SD)% N (M ± SD)%
Sample 1
FMCE Pretest 3511 2607 45 ± 28 904 30 ± 22
FMCE Post-test 3016 2192 74 ± 26 824 59 ± 28
Sample 2
FMCE Pretest 3956 3146 25 ± 19 810 20 ± 14
FMCE Post-test 3719 2947 53 ± 28 772 41 ± 24
Summary of Results
While Traxler et al. [1] identified five items on the FCI post-test that were substantially unfair to female students, this was not the case for the FMCE. While most FMCE items were significantly more difficult for women (with no more than a small effect size), no item stood out as substantially unfair.
A Differential Item Functioning (DIF) analysis, which assumes the post-test score to be an accurate measure of overall ability, showed that only item 27_29 had large DIF for both samples. This result was different than the work done by Traxler et al. [1] identified 9 items having large DIF in the FCI.
Binning by FMCE pretest score, no gender gap was found for the least prepared students. This suggests that there is not an overall instrumental bias in the FMCE.
[1] A. Traxler, R. Henderson, J. Stewart, G. Stewart, A. Papak, and R. Lindell. Gender fairness within the Force Concept Inventory. arXiv preprint arXiv:1709.00437, 2017.
CTT Difficulty Male Students
CTT Difficulty Female Students
Sample 1 FMCE Pretest
Sample 1 FMCE Posttest
Sample 2 FMCE Pretest
Sample 2 FMCE Posttest
Methods
Students were enrolled in the introductory, calculus-based mechanics course and the FMCE was given pre- and post-instruction (n1 = 6,527, n2 = 7,675)
Sample 1: Research was conducted at a large western land-grant university serving approximately 34,000 students (ACT range: 25-30)
Sample 2: Research was conducted at a large eastern land-grant university serving approximately 30,000 students (ACT range: 21-26)
Thornton Scoring
Items 5, 6, 15, 33, 35, 37, and 39 were eliminated
"All-or-nothing" scoring for three clusters of items examining acceleration (8_10, 11_13, and 27_29)
Mantel-Haenszel (MH) statistic
Used to determine whether two variables are independent of one another while conditioning on a third variable
For each level of ability: αMH = Σk odds of success for reference group (male) / Σk odds of success for focal group (female)
ΔαMH = −2.35 ln(αMH)
Negligible DIF: |ΔαMH| < 1
Small to moderate DIF: 1 ≤ |ΔαMH| < 1.5
Large DIF: |ΔαMH| ≥ 1.5
ΔαMH = 0 No DIF
ΔαMH < 0 Advantage Male
ΔαMH > 0 Advantage Female
Item ΔαMH
Sample 1
27_29 -1.50
Sample 2
27_29 -1.66
40 -1.62
Pretest Analysis
Sample 1
Sample 2
FMCE Pretest Score
WEST VIRGINIA UNIVERSITY
Physics and Astronomy

Laboratory Notebook Practices

LEWIS UNIVERSITY
A Catholic and Lasallian University

Michael Zwartz, Joseph F. Kozminski
Department of Physics, Lewis University, Romeoville, IL 60446

Introduction

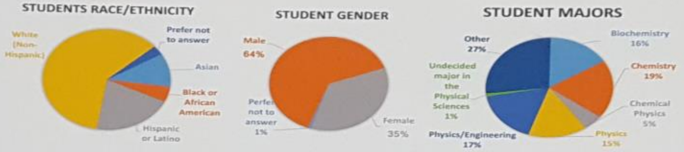
- Keeping a laboratory notebook is a critical practice in any science laboratory:
  - AAPT Lab recommendations call of an increased focus on teaching students proper lab notebook techniques.[1]
  - A study shows that first year graduate students do not feel prepared for the level of scientific documentation needed for graduate level research.[2]
  - Lab notebooks are an excellent way to assess a students understanding of the physics concepts during an undergraduate lab.[3]
- This research studies **the level of training undergraduate students receive and if that training is sufficient in preparing them for graduate level research or research in industry**. The survey also examines **students beliefs, practices, and attitudes toward laboratory notebooks.**

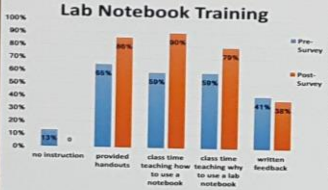
Methods

- Research has been conducted through a series of pre- and post-surveys taken by undergraduate students in (calculus-based) General Physics 1, 2, and 3 Laboratory courses over multiple semesters. Below is an excerpt from the survey.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
10. I find it useful to keep a lab notebook.	1	2	3	4	5
11. I often wait until the end of an experiment or lab period to write in my lab notebook.	1	2	3	4	5
12. I keep careful, detailed records of my lab work in my lab notebook.	1	2	3	4	5
13. I am confident in my ability to keep a good lab notebook.	1	2	3	4	5
14. Keeping a lab notebook is tedious.	1	2	3	4	5
15. I would rather take data and notes on a piece of scratch paper and transfer them into my lab notebook after class than write in my lab notebook during lab.	1	2	3	4	5

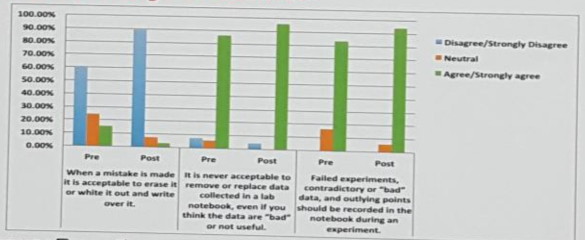
Demographic Information:





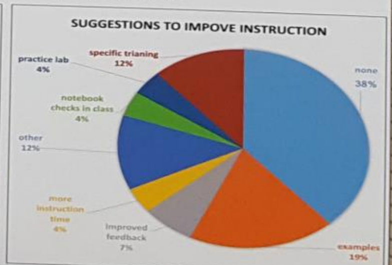
Students come into general physics with many different backgrounds and experiences with laboratory notebooks. Across the board we see an increase in notebook training which is important for students focused in science fields.

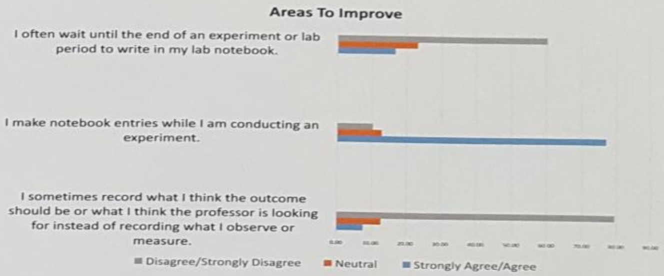
Preliminary Results:



Above: From the pre to post survey from the first semester we see significant improvement in students attitudes and beliefs on data collection.

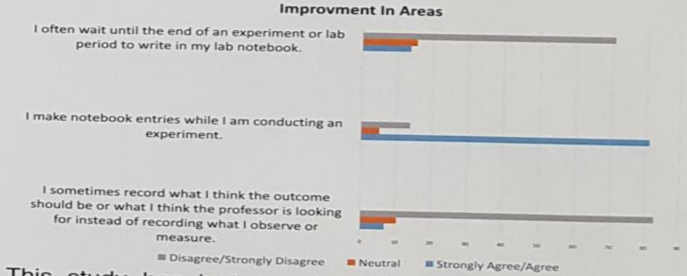
Below: Short response analysis shows which types of instruction students felt best trained them and in which areas students want to see more preparation.





Above: Preliminary results show several areas students still need improvement after one semester of laboratory work.

Below: After a second semester, we see significant improvement.



This study has just completed its third semester of data collection. It already shows short term improvements with additional time spent developing lab notebook skills at the introductory level through two semesters. Ultimately, this longitudinal study will compare the lab notebook practices and attitudes for physics students with formal training in General Physics and students without it in the upper level laboratory courses and capstone.

References

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WHAT IS YOUR INTUITION'S ASSESSMENT PRACTICES?