CAE's Tier I Teaching Excellence Workshop

for

Current and Future Astronomy & Space Science Instructors

A Two-Day Workshop

Sat. & Sun. 8:00am-5:30pm

Presenters

Ed Prather

CAE, Steward Observatory, Univ. of Arizona

Gina Brissenden

CAE, Steward Observatory, Univ. of Arizona

http://astronomy101.jpl.nasa.gov

Special Thanks To:

JPL's NASA Exoplanet Exploration Public Engagement Program

AUI/NRAO

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Note for Tomorrow!

- We need to know who WILL NOT be here during the first few hours of tomorrow.
  – Don’t take on an implementation role in your Think-Pair-Share Group (this will make more sense later)
- We also need to know who WILL NOT be here at the very end of tomorrow.
  – Tell us before you leave for lunch today!

Note for Your Time Here

- You are free to take a bathroom/walk-around break any time you wish
- Please do not check email or surf the web during sessions (tempting as it is)
- Please disconnect from the outside world (turn off cell phones)

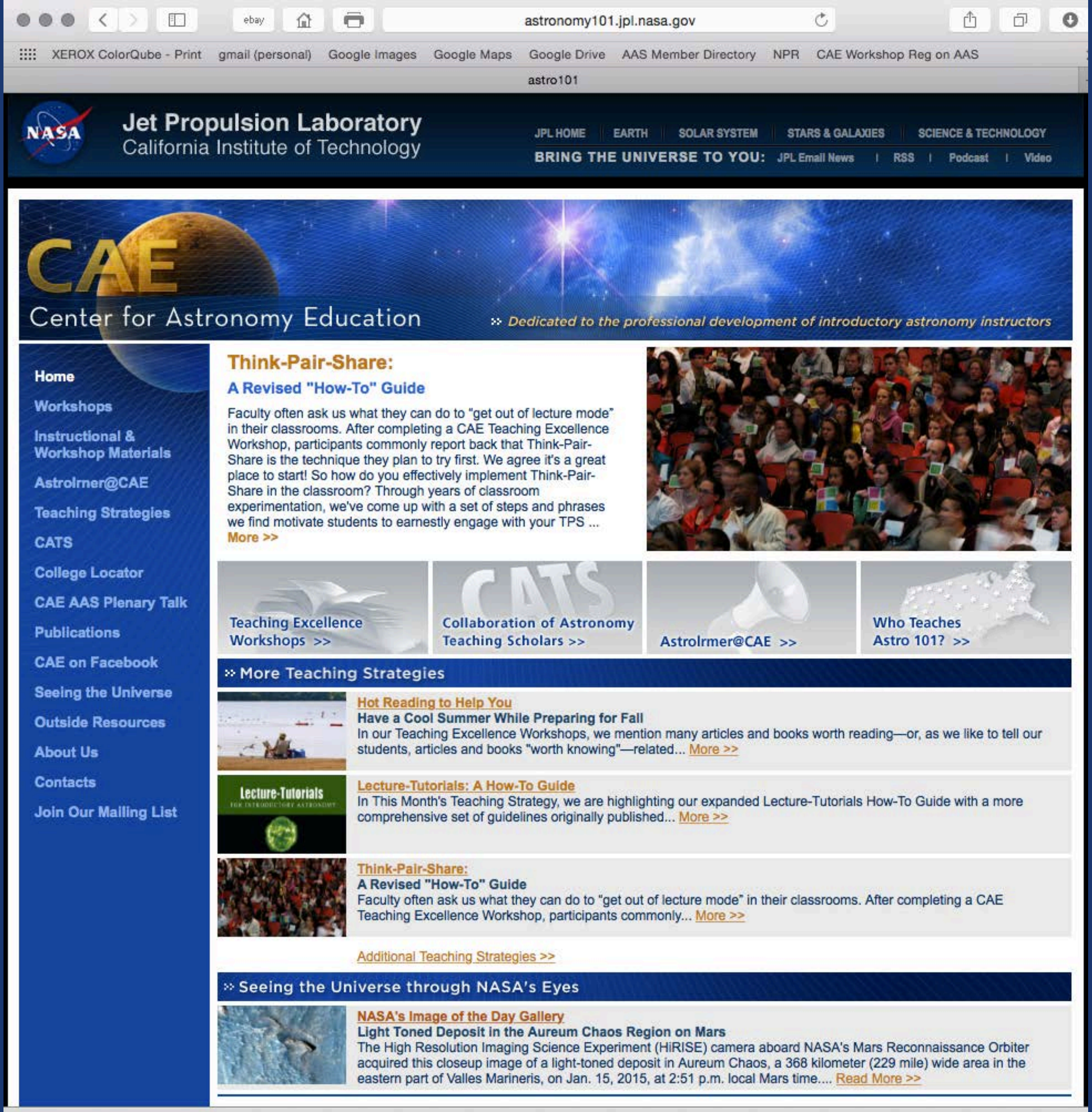
As Yet Unanswered Burning Questions

Introductions

Take <u>10 seconds</u> to tell us a little about yourself

Take Home Messages

- Research-validated interactive learning strategies can benefit ALL students in ALL classroom environment - BUT
- The quality of our implementation is likely the most deterministic factor toward student achievement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Think-Pair-Share:
A Revised "How-To" Guide
Faculty often ask us what they can do to "get out of lecture mode" in their classrooms. After completing a CAE Teaching Excellence Workshop, participants commonly report back that Think-Pair-Share is the technique they plan to try first. We agree it's a great place to start! So how do you effectively implement Think-Pair-Share in the classroom? Through years of classroom experimentation, we've come up with a set of steps and phrases we find motivate students to earnestly engage with your TPS ...
More >>
Teaching Excellence Workshops >>
Collaboration of Astronomy Teaching Scholars >>
Astrolrner@CAE >>
Who Teaches Astro 101? >>
More Teaching Strategies
Hot Reading to Help You
Have a Cool Summer While Preparing for Fall
In our Teaching Excellence Workshops, we mention many articles and books worth reading—or, as we like to tell our students, articles and books "worth knowing"—related... More >>
Lecture-Tutorials: A How-To Guide
In This Month's Teaching Strategy, we are highlighting our expanded Lecture-Tutorials How-To Guide with a more comprehensive set of guidelines originally published... More >>
Think-Pair-Share:
A Revised "How-To" Guide
Faculty often ask us what they can do to "get out of lecture mode" in their classrooms. After completing a CAE Teaching Excellence Workshop, participants commonly... More >>
Additional Teaching Strategies >>
Seeing the Universe through NASA's Eyes
NASA's Image of the Day Gallery
Light Toned Deposit in the Aureum Chaos Region on Mars
The High Resolution Imaging Science Experiment (HiRISE) camera aboard NASA's Mars Reconnaissance Orbiter acquired this closeup image of a light-toned deposit in Aureum Chaos, a 368 kilometer (229 mile) wide area in the eastern part of Valles Marineris, on Jan. 15, 2015, at 2:51 p.m. local Mars time.... Read More >>

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- Workshops
  - About the Presenters
- Instructional & Workshop Materials
- AstroImer@CAE
- Teaching Strategies
- CATS
- College Locator
- CAE AAS Plenary Talk
- Publications
- CAE on Facebook
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- Outside Resources
- About Us
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Workshops

Teaching Excellence Workshops

Since 2004, CAE workshops have reached 3,554 participants from all 50 states, DC, Puerto Rico, Canada, South America, Europe, Asia, and Africa.

Workshops Locations
Click a location to register for a specific workshop

Fall/Winter 2014/15

1. Jamestown, North Carolina
   Regional Teaching Exchange
   October 4, 2014
2. College Park, Maryland
   New Faculty Workshop
   November, 2014
3. Seattle, Washington
   Tier I,CATS
   January 3 - 4, 2015

Spring/Summer 2015

4. East Lansing, Michigan
   Regional Teaching Exchange
   April 10, 2015
5. Oceanside, California
   Regional Teaching Exchange
   May 2, 2015
6. Orangeburg, South Carolina
   Tier I,CATS
   June 13-14, 2015
7. College Park, Maryland
   New Faculty Workshop
   June 22-25, 2015
8. Honolulu, Hawaii
   Tier I,Special Topics
   August 4, 2015

Fall/Winter 2015/2016

12. Milwaukee, Wisconsin
    Tier I,CATS
    September 26-27, 2015
13. Jamestown, North Carolina
    Regional Teaching Exchange
    October 3, 2015
14. Everett, Washington
    Regional Teaching Exchange
    October 17, 2015
15. College Park, Maryland
    New Faculty Workshop
    November, 2015
16. Kissimmee, Florida
    Tier I
    January 3-4, 2016

astro101: Instructional & W

astronomy101.jpl.nasa.gov/workshopmateriallist/

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Instructional & Workshop Materials

Workshop Materials for Past Participants

1. **Images from Lecture-Tutorials for Introductory Astronomy, Third Edition**
   Here you will find individual .jpg versions of all the artwork in Lecture-Tutorials for Introductory Astronomy, Third Edition. You will also find Power Point slides of each image grouped by sections in the book.
   - Images from Lecture-Tutorials for Introductory Astronomy, Third Edition (Zip, 41.69 MB)

2. **Voting Card**
   - A-B-C-D Voting Card (PDF, 115 KB)

3. **Detecting Exoplanets Curriculum**
   - Lecture-Tutorial: Detecting Exoplanets with the Transit Method (DOCX, 1.71 MB)
   - Lecture Slides: Detecting Exoplanets with the Transit Method (PPTX, 2.31 MB)

4. **Radio Curriculum**
   - Lecture-Tutorial: Rotation, Vibration, and Synchrotron Radiation – Astronomical Interactions of Light and Matter (DOCX, 951 KB)
   - Lecture Slides: Rotation, Vibration, and Synchrotron Radiation – Astronomical Interactions of Light and Matter (PPTX, 3.94 MB)
   - Assessment Questions: Rotation, Vibration, and Synchrotron Radiation – Astronomical Interactions of Light and Matter (DOCX, 695 KB)

5. **Unpublished Ranking Tasks**
   - Apparent & Absolute Magnitude
     - Activity 1 (PDF, 151 KB)
     - Activity 2 (PDF, 78 KB)
     - Activity 3 (PDF, 80 KB)
     - Activity 4 (PDF, 70 KB)
   - Doppler Shift
     - Activity 1 (PDF, 145 KB)
     - Activity 2 (PDF, 72 KB)
     - Activity 3 (PDF, 70 KB)
     - Activity 4 (PDF, 68 KB)
   - Gravity
     - Activity 1 (PDF, 95 KB)
     - Activity 2 (PDF, 346 KB)
     - Activity 3 (PDF, 64 KB)
     - Activity 4 (PDF, 287 KB)
     - Activity 5 (PDF, 398 KB)

NSF: Collaboration of Astronomy Teaching Scholars (CATS)

- Leilani Arthurs, UNL
- Duncan Brown, Syracuse Univ.
- Sanlyn Buxner, Univ. of Arizona
- David Consiglio, Bryn Mawr College
- Tim Chambers, U Michigan
- Steve Desch, Guilford Tech. CC
- Doug Duncan, CU Boulder
- Jeffrey Eckenrode, Pacific Science CTR
- Tom English, Guilford Tech. CC
- John Feldmeier, Youngstown State Univ.
- Amy Forestell, SUNY New Paltz
- Rica French, MiraCosta College
- Adrienne Gauthier, Dartmouth
- Pamela Gay, SIU-Edwardsville
- Dennis Hands, High Point Univ.
- Kevin Hardegree-Ullman, University of Toledo
- Melissa Hayes-Gehrke, Univ. of Maryland
- Seth Hornstein, CU Boulder
- David Hudgins, Rockhurst Univ.
- Chris Impey, Univ. of Arizona
- Jessica Kapp, Univ. of Arizona
- John Keller, Cal Poly SLO
- Julia Kregenow, Penn State
- Michelle Wooten, Univ of Alabama
- Kevin Lee, UNL & NSF
- Patrick Len, Cuesta College
- Chris Lintott, Univ. of Oxford
- Michael LoPresto, Henry Ford CC
- Daniel Loranz, Truckee Meadows CC
- Julie Lutz, Univ. of Washington
- Danny Martino, Santiago Canyon College
- Benjamin Mendelsohn, West Valley College
- Ed Montiel, Louisiana State University
- Peter Newbury, Univ. of British Columbia
- Lee Powell, UN Kearney
- Matthew Price, Ithaca College
- Jordan Raddick, Johns Hopkins Univ.
- Alex Rudolph, Cal Poly - Pomona
- Travis Rector, Univ. of Alaska
- Paul Robinson, Westchester CC
- Wayne Schlingman, Ohio State
- Sébastien Cormier, San Diego College
- Colin Wallace, UNC
- Kathryn Williamson, NRAO
- James Wysong Jr., Hillsborough CC
- Todd Young, Wayne St. College

Getting Our "Challenges" on the Table

- Time, time, time!
- Department support
- Teaching resources
- Etc…

The REAL *challenge is* IMPLEMENTATION!!!!

Expectations

- This is an important time to share and to learn:
  - Engage yourself in as many discussions as possible (among the participants and presenters, there is enormous expertise and experience around the room)
  - Critically examine your own beliefs about teaching and learning and respectfully question others' rationale
- If you didn't learn anything new in a particular session, you may need to engage more actively!

Perspectives on Teaching in the interactive Learning Environment

"I'm comfortable engaging with my students."

"I know how to get my students to intellectually engage in critical reasoning."

"I know how to create highly interactive learning environments that get my students collaborating."

"I know what to do when my students get stuck."

"I know how to handle a group that is asking for answers."

"I know how to handle a group that is not collaborating."

etc., etc., etc…

Rank the Following From Greatest to Least:

1. Research on students' attitudes, beliefs and motivations regarding the learning of your discipline.

2. Research on the factors that lead to high fidelity implementation of research-validated instructional strategies.

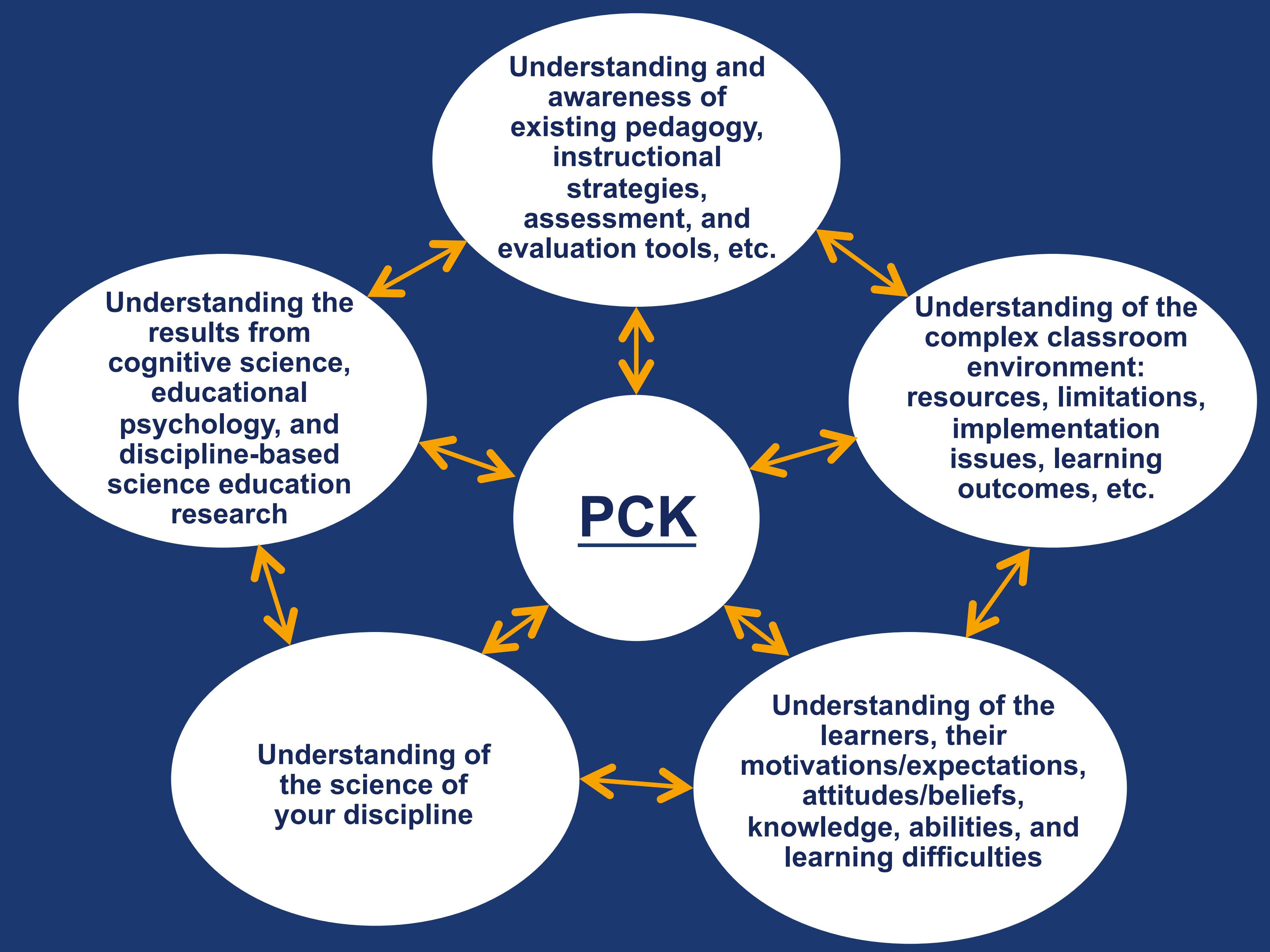
3. Research into students' conceptual and reasoning difficulties with commonly taught topics of your discipline.

4. Research on the development and validation of interactive teaching methods proven to increase discipline knowledge and abilities.

5. Research on students' attitudes and beliefs about the role of your discipline in society

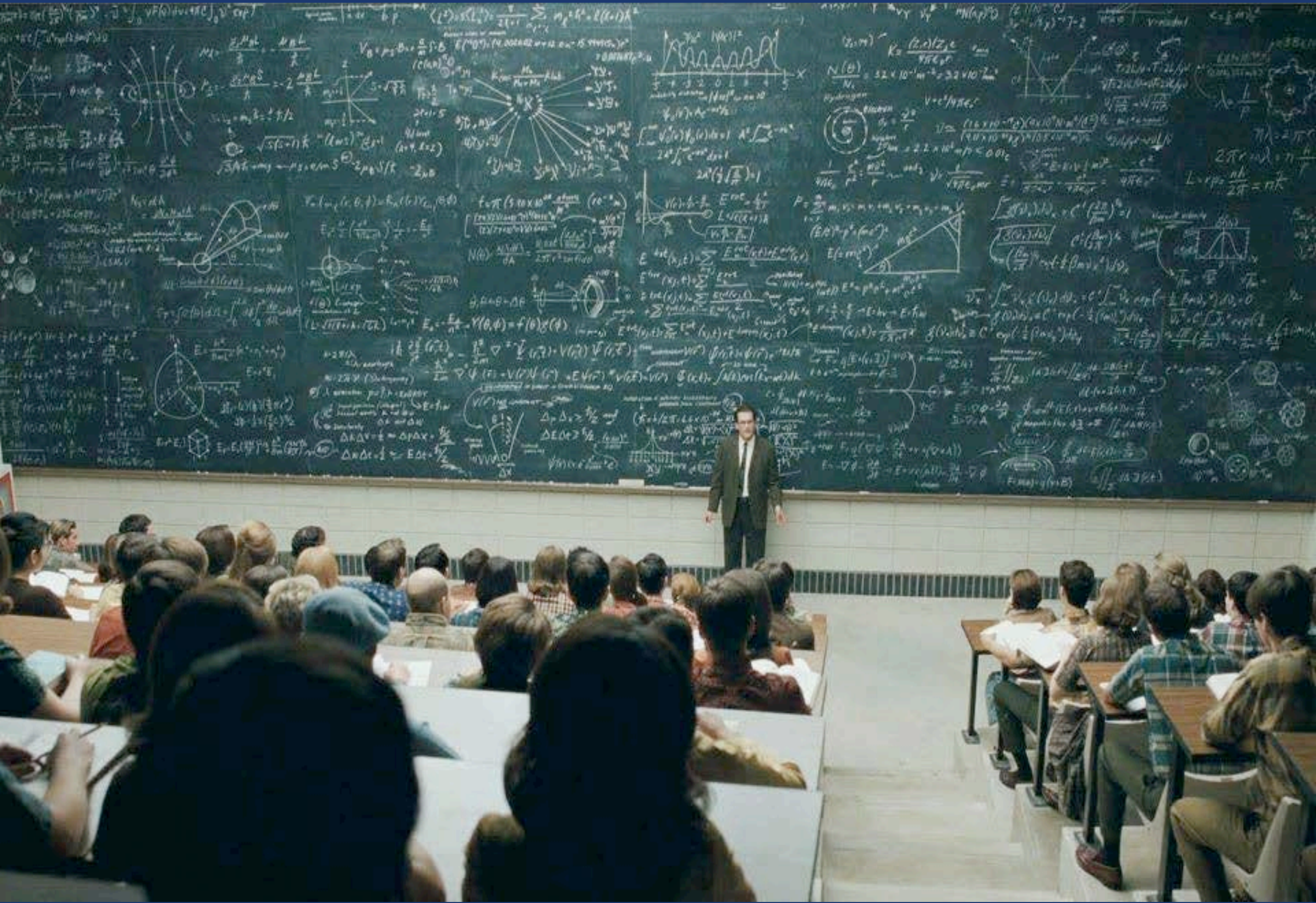
6. Research on the affects of interactive teaching methods on underserved populations

7. Research on assessment strategies that can uncover learners state of knowledge and the effectiveness of instructional strategies


Understanding and awareness of existing pedagogy, instructional strategies, assessment, and evaluation tools, etc.
Understanding the results from cognitive science, educational psychology, and discipline-based science education research
PCK
Understanding of the complex classroom environment: resources, limitations, implementation issues, learning outcomes, etc.
Understanding of the science of your discipline
Understanding of the learners, their motivations/expectations, attitudes/beliefs, knowledge, abilities, and learning difficulties

Education is the formal process by which society deliberately passes on its accumulated knowledge, skills, customs and values from one generation to another.*

* Adapted from: Don Berg: "Definition of Education” (http://www.teach-kids-attitude-1st.com/definition-of-education.html)



"Most ideas about teaching are not new, but not everyone knows the old ideas." Euclid (300 B.C.)

A Commonly Held Inaccurate Model of Teaching and Learning

Your discipline content

Bill Watterson,
Calvin and Hobbs

Goals of the modern classroom….

- Helping to prepare citizens to be productive members of society.

- Discipline knowledge and discipline literacy

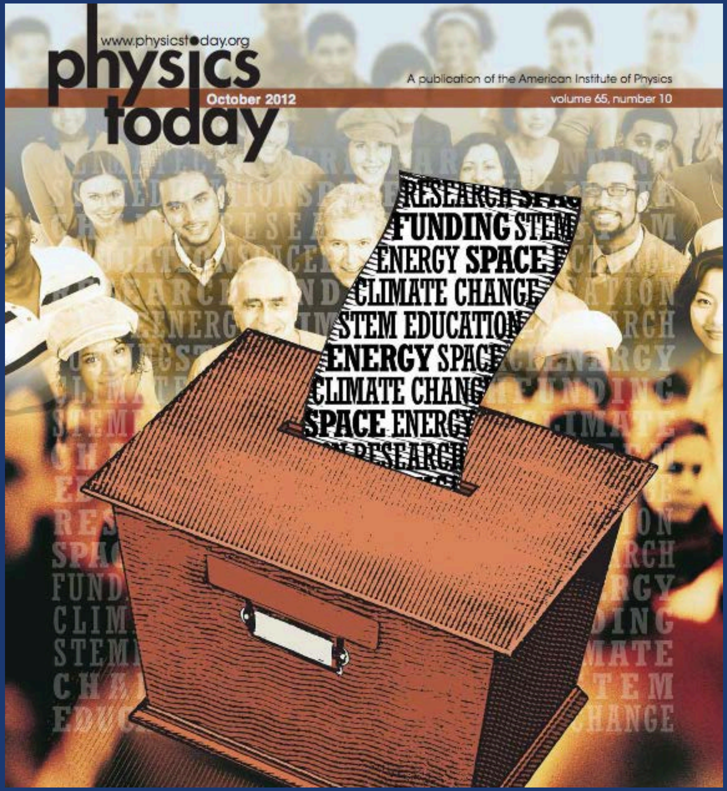
- Critical thinking and problem solving skills

- Ability to communicate effectively about complex ideas

- Ability to work with information and data

- Etc……

… it feels as though we are living in the time of the *"gathering storm"* in a *"nation at risk"*.



Why study or teach Gen. Ed. Earth, Astronomy and Space Science?

- 500,000 students take this class each year.
- *20% of all college students* will take a Gen. Ed. EASS course at sometime in their college career.
- For many of these students, this will be their last and only exposure to science in college.
- These students are our future: our future scientists (up to 25%), technologists, artists, lawyers, business leaders, journalists, politicians, *teachers* (20-40% of our classes), and policy makers, voters, taxpayers, parents, citizens…
- *In using evidence-based practices to teach Gen. Ed. EASS, we can positively influence the scientific literacy and beliefs of a large fraction of our future citizenry, and make significant impact on the diversity and retention issues in STEM.*

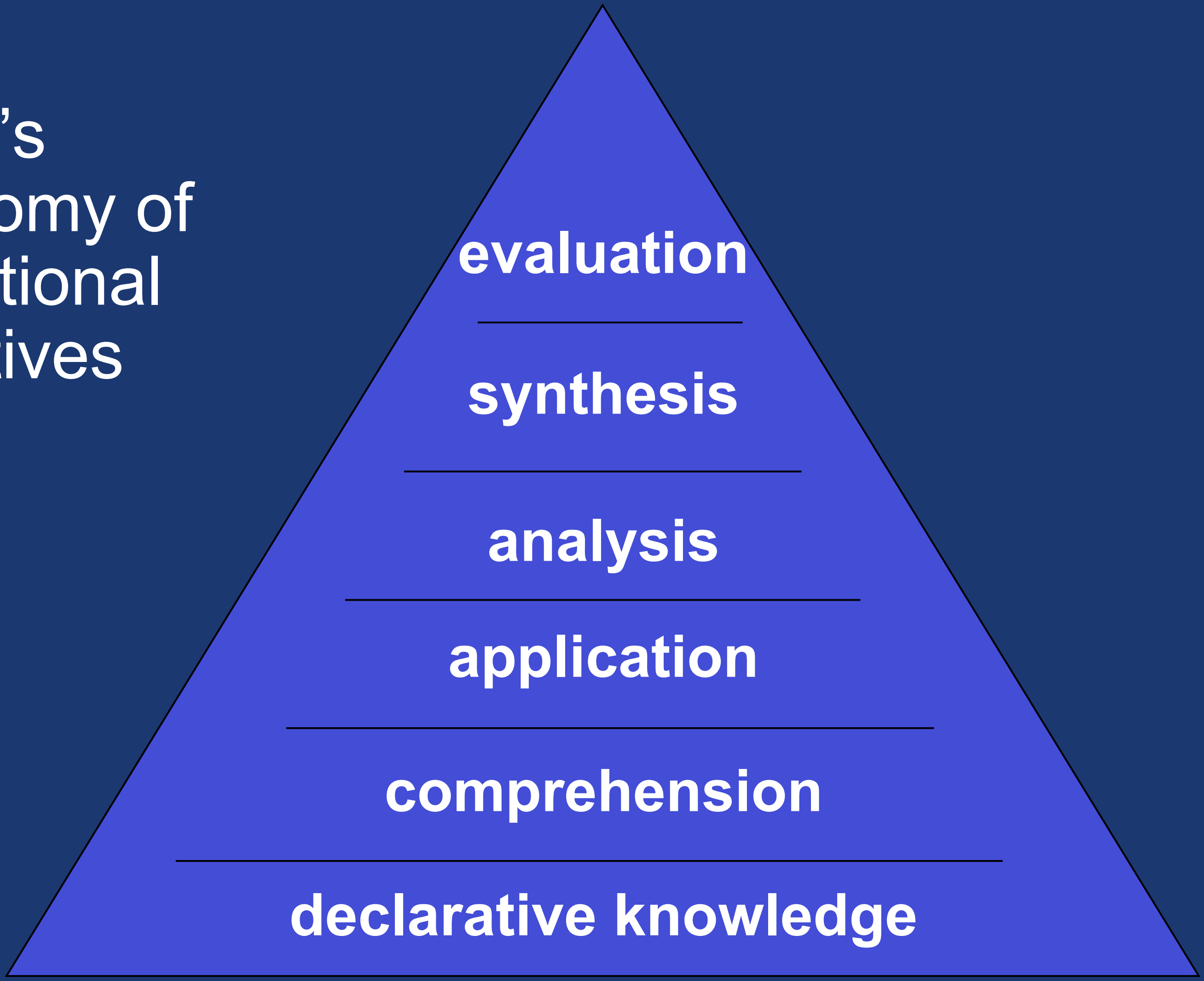
adapted from "How People Learn"

- Students enter the classroom with preconceptions about how the world works. *If their initial understanding is not fully engaged, they may fail to grasp new concepts in meaningful ways that last beyond the purposes of an exam.*
- To fully develop competence, students must:
  (1) have a deep foundation of factual knowledge, (2) understand the interrelationships among facts and ideas in the context of a conceptual framework, and (3) organize knowledge in ways that facilitate retrieval and application
- A "metacognitive" approach to instruction can help students learn to take control of their own learning and monitor progress.

How People Learn: Brain, Mind, Experience, and School (Expanded Edition),
National Research Council, National Academy Press, 2000.

Does your class intellectually engage your students and deepen their conceptual understanding and critical thinking ability or does it re-enforce the memorization of facts and declarative knowledge?

Bloom's Taxonomy of Educational Objectives



The Role of Assessment in the Development of the College Introductory Astronomy Course A "How-to" Guide for Instructors. Astronomy Education Review, 1(1), 1-24, 2002. G. Brissenden, T.F. Slater, and R. Mathieu.

Astro 101: "Setting the Academic Bar"

Do your best to work through these questions which are used in our Learner-Centered Astro 101 course.

Do your students ever achieve this level of understanding?

WHY or WHY NOT?

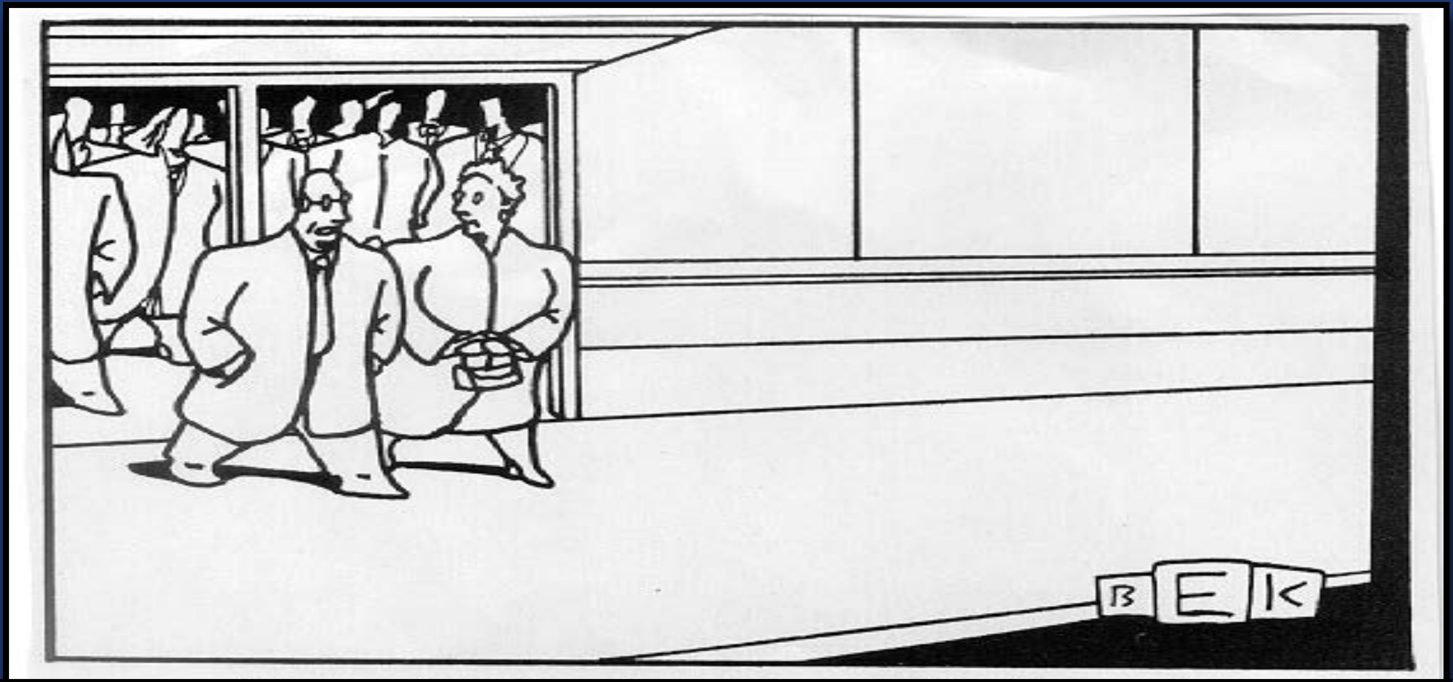
Let's discuss some of the sample questions…

5 min break

What Can I do Besides Lecture to Engage Students in their Learning?

- Ask students questions (not all questions are equal)
- In-class writing (with or without discussion)
  - Muddiest Point
  - Summary of Today's Main Points
  - Writing Reflections
- Use interactive videos, demonstrations, animations, and simulations
- Think-Pair-Share or PeerInstruction
- Small Group Interactions
  - Concept Maps
  - Case Studies
  - Sorting Tasks
  - Ranking Tasks
  - Lecture-Tutorials
- Student Debates (individual/group)
- Whole Class Discussions

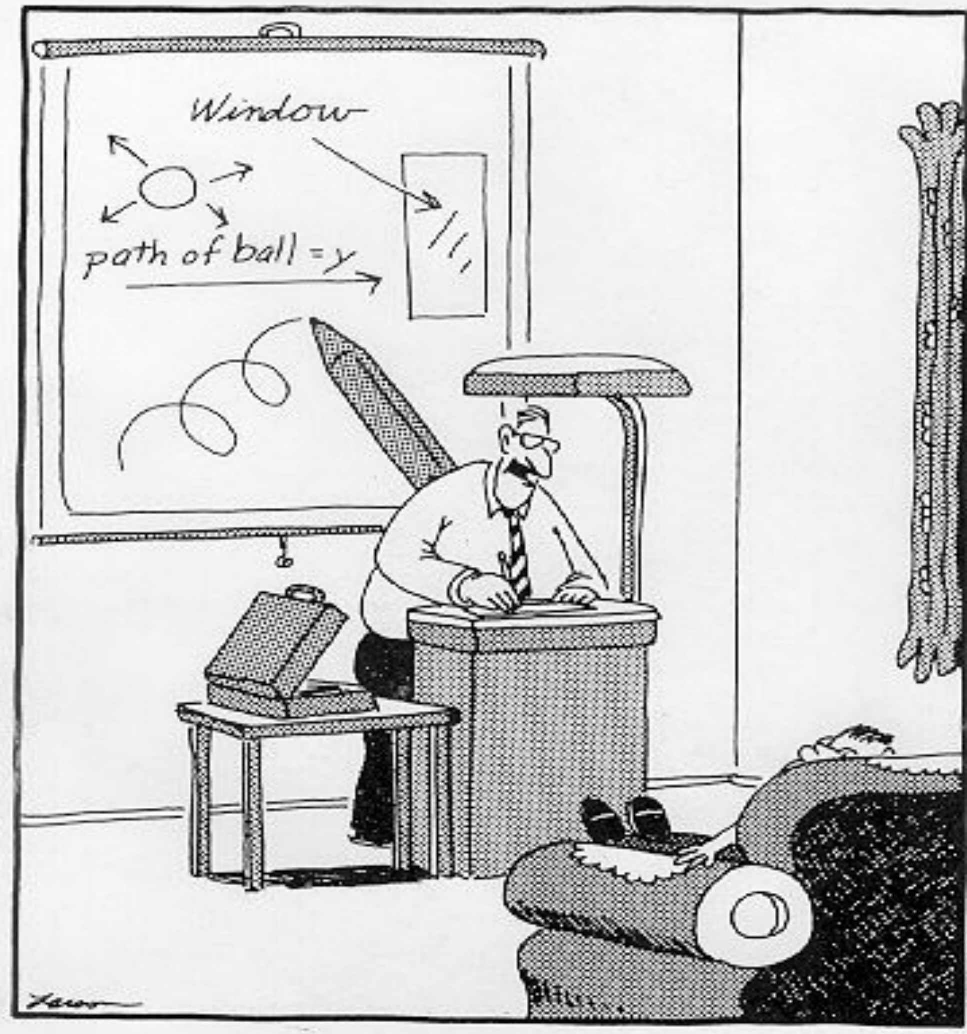
Another talk about teaching and learning…..



"I've seen it performed many times, but I can't remember ever sleeping through it so peacefully."

If a Picture is worth a thousand words, then what is a real-world, first-hand, experience worth?

- Audience participation is strongly encouraged
- Demos are sometimes life-threatening



Eventually, Billy came to dread his father's lectures over all other forms of punishment.

“Eventually, Billy came to dread his father’s lectures over all other forms of punishment”

The Montillation of Traxoline

It is very important that you learn about traxoline. Traxoline is a new form of zionter. It is montilled in Ceristanna. The Ceristannians gristerlate large amounts of fevon and then brachter it to quasel traxoline. Traxoline may well be one of our most lukized snezlaus in the future because of our zionter lescelidge.

-Judy Lanier, Institute for Research on Teaching, Univ. of Michigan

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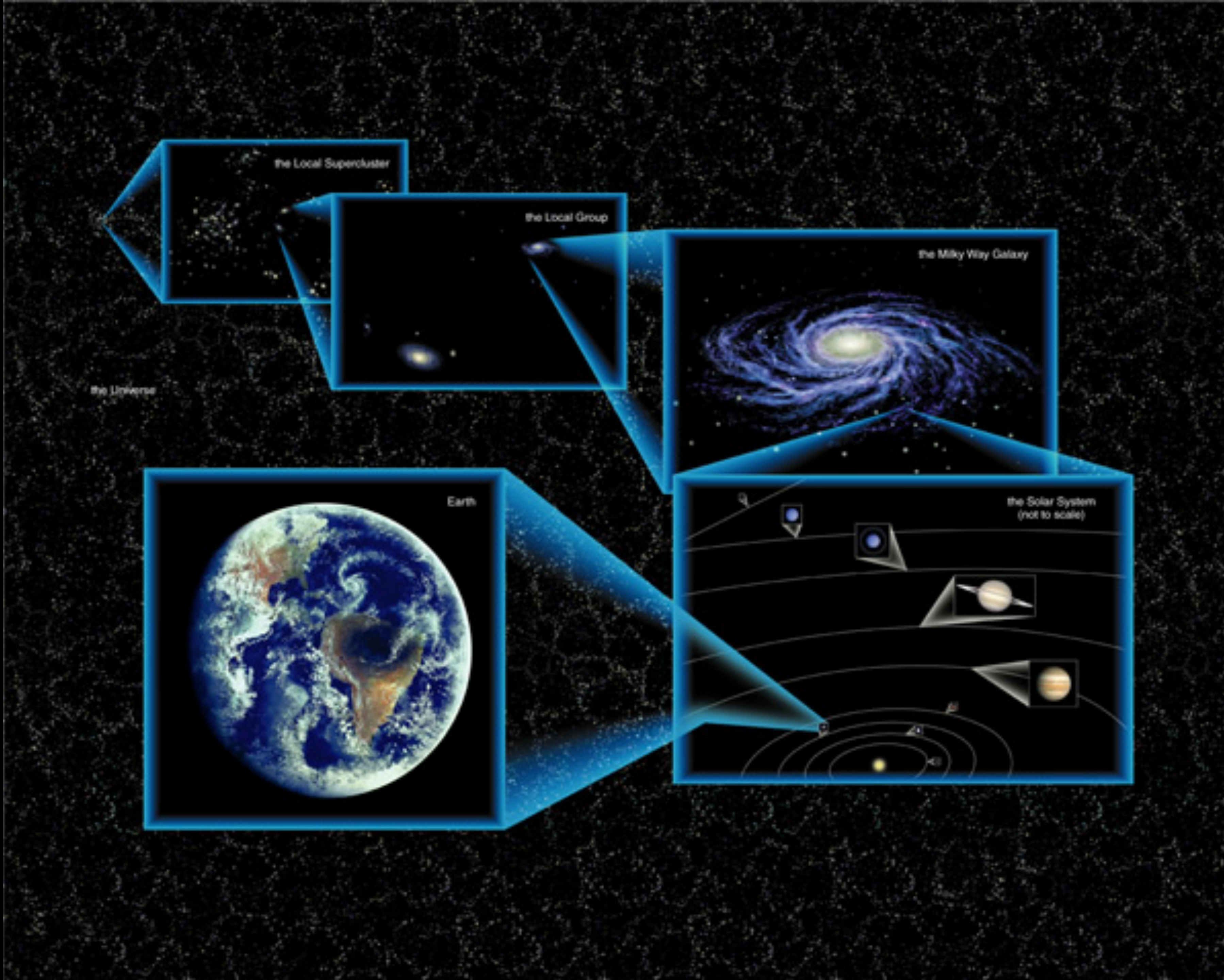
Directions: Answer the following questions in complete sentences. Be sure to use your best handwriting.

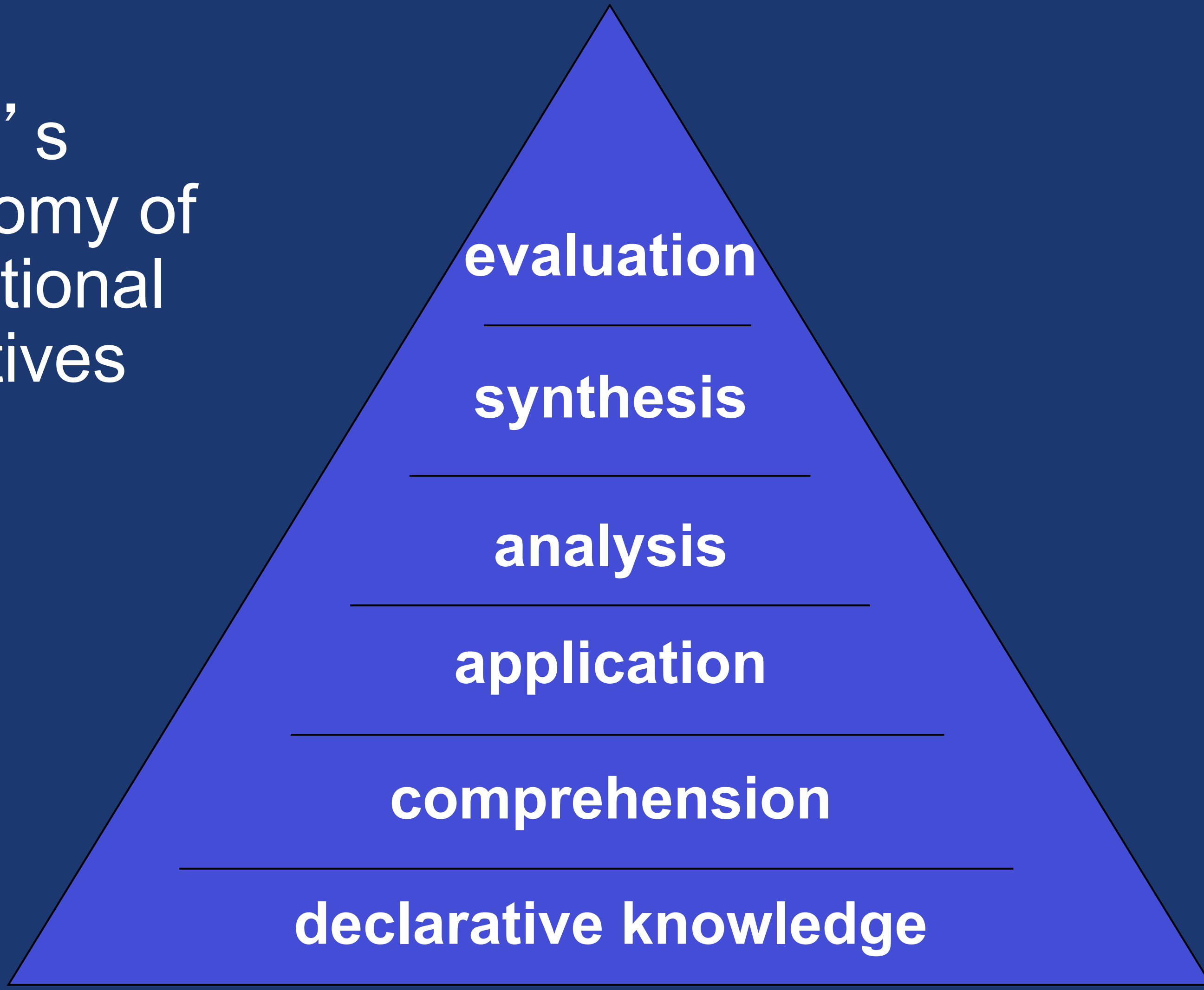
1. **What is traxoline?**
2. **Where is traxoline montilled?**
3. **How is traxoline quaselled?**
4. **Why is it important to know about traxoline?**

"Lecture has often been described as the process of taking the information contained in the teachers notes and transferring them into the students notes without the information passing through the brains of either"


the Local Supercluster
the Local Group
the Milky Way Galaxy
the Universe
Earth
the Solar System
(not to scale)

Does your class intellectually engage your students and deepen their conceptual understanding and critical thinking ability or does it re-enforce the memorization of facts and declarative knowledge?

Bloom's Taxonomy of Educational Objectives



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Let's See a REAL Interactive Lecture!

"Motion of Extrasolar Planets"

Your job is to pay attention to:

Instructional Strategies…
Implementation Techniques…
Motivational Techniques…

Let’s Discuss The Lecture

- Instructional Strategies…
- Implementation Techniques…
- Motivational Techniques…

Stay focused on these issues in our discussion!

What Can I do Besides Lecture to Engage Students in their Learning?

- Ask students questions (not all questions are equal)
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  - Summary of Today's Main Points
  - Writing Reflections
- Use interactive videos, demonstrations, animations, and simulations
- Think-Pair-Share or Peer Instruction
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Issues with Questioning in the Classroom

- ✓ Insufficient "Wait-Time"
- ✓ The Rapid-Reward
- ✓ The Programmed Answer
- ✓ Non-Specific Feedback Questions
- ✓ Fixation at a Low-Level of Questioning

A Short Note About the Use of Active Questioning Techniques

– Provides feedback for you and your students
– Demonstrates to each student how their understanding compares to the rest of the class
– Provides motivation for your students to do your in-class activity
– Provides your students with examples of “test day”
– Lets YOU know how you’re doing at presenting your material and how well your students are doing at understanding it.

What Can I do Besides Lecture to Engage Students in their Learning?

- Ask students questions (not all questions are equal)
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  - Elicitation or “Current Thoughts”
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A Short Note About In-Class Writing

Writing promotes critical thinking and metacognition. It makes students' current knowledge-state explicit, helps students develop their understanding of concepts taught in class, and/or provides opportunities for students to use critical reasoning skills to solve "real" problems and answer "real" questions.

"How can I know what I think until I see what I say" (W. H. Auden, 1962)

Some Examples of In-Class Writing Prompts

- Describe the scientific evidence that supports evolution.
- Explain how light from the Sun and Earths surface interact with the atmosphere to produce the Greenhouse Effect.
- Over the last 150 years, what three science discoveries have made the greatest impact on mankind's quality of life.
- What about the enterprise of science makes it different than business?
- If we establish communication with an intelligent, extraterrestrial civilization, who should speak for Earth and what should he/she/they say?
- What are the three main points from todays class?
- What are the two topics you would like me to re-teach when we come back to class – OR – What are the two topics you are most concerned about for test day?

What Are Your Thoughts?

Take 5 minutes to respond to the following:

- Describe what your job is (what you need to be doing) to ensure that your implementation of active learning strategies will be effective with your students.

Let’s Take a 5 Minute Break!

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A Short Note About Interactive Videos, Demonstrations, Animations, and Simulations

Student thinking is made explicit and held accountable through the use of writing down predictions BEFORE the video, demo, etc. is shown and outcomes are provided. By actively engaging your students in making predictions about the outcome, you elevate the intellectual merit of the activity, and you extend the teachable moment by creating a desire in your students to keenly observe your activity to see if their predictions are correct.

Tobias, S. *Revitalizing Undergraduate Science-Why Some Things Work and Most Don't,* Research Corporation, 1992.

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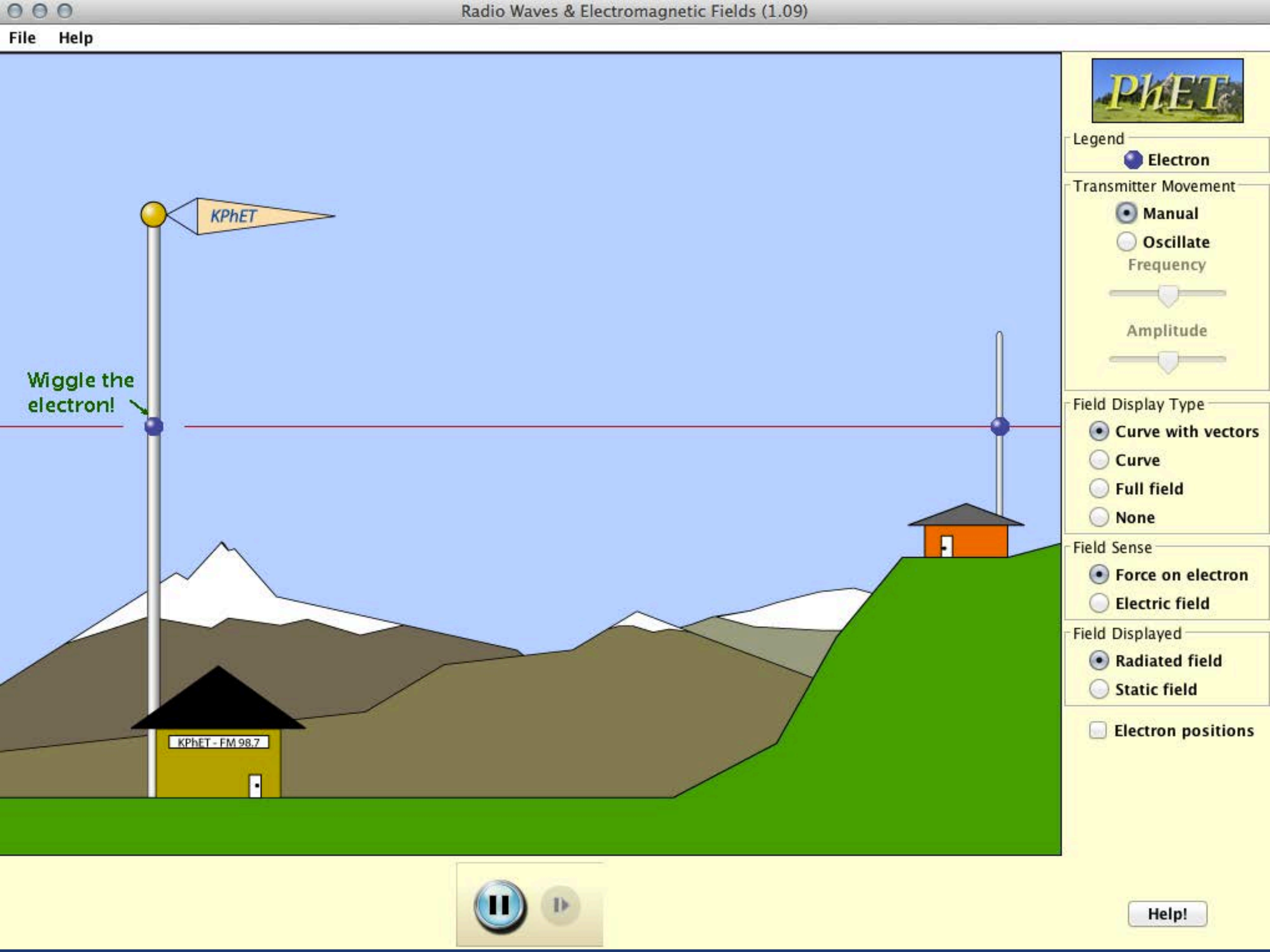

Radio Waves & Electromagnetic Fields (1.09)
File
Help
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Wiggle the electron!
KPhET - FM 98.7
PhET
Legend
Electron
Transmitter Movement
Manual
Oscillate
Frequency
Amplitude
Field Display Type
Curve with vectors
Curve
Full field
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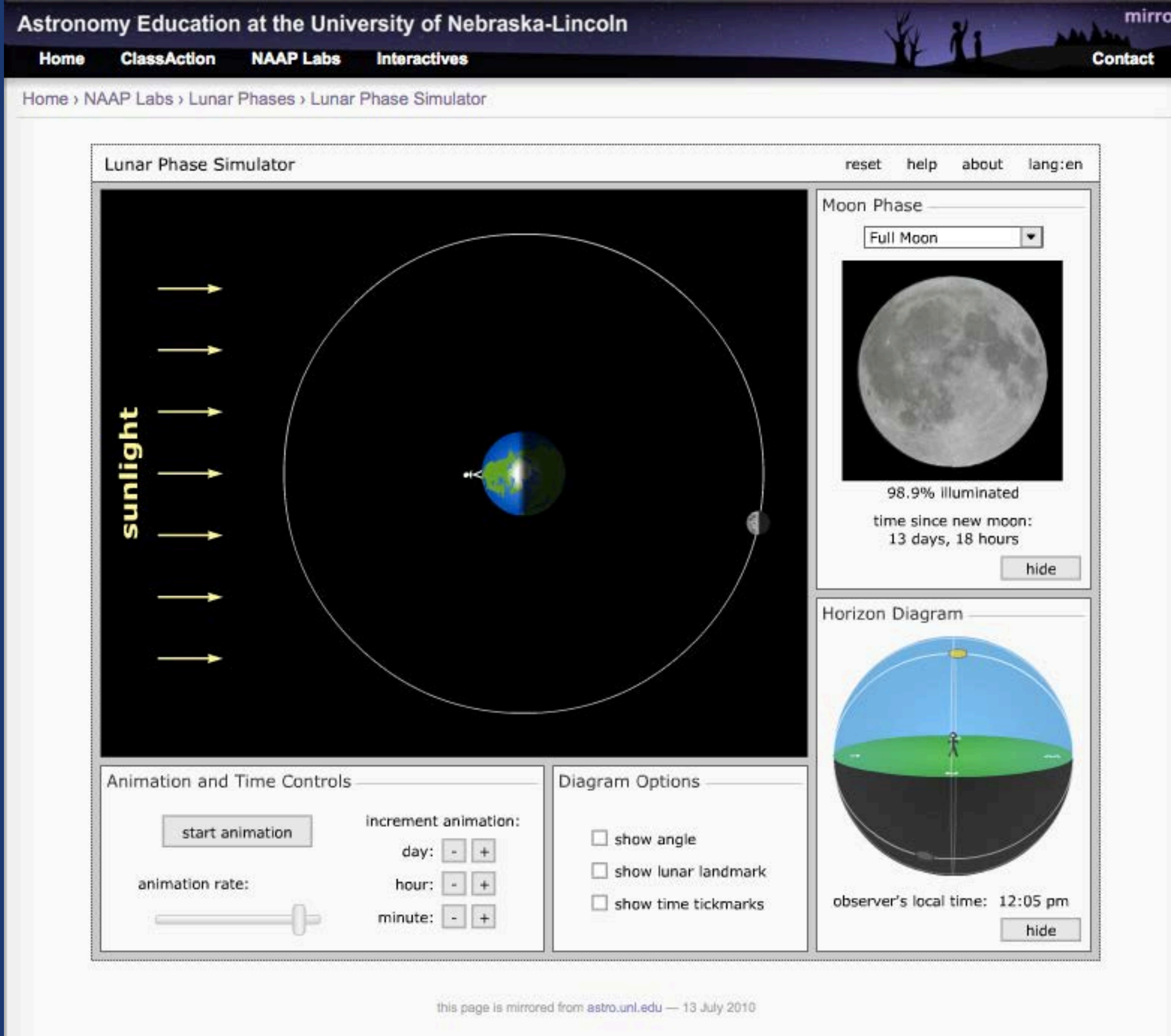
Field Sense
Force on electron
Electric field
Field Displayed
Radiated field
Static field
Electron positions
Help!


Astronomy Education at the University of Nebraska-Lincoln
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Home › NAAP Labs › Lunar Phases › Lunar Phase Simulator
Lunar Phase Simulator
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sunlight
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Full Moon
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time since new moon:
13 days, 18 hours
hide
Horizon Diagram
observer's local time: 12:05 pm
hide
Animation and Time Controls
start animation
animation rate:
increment animation:
day:
hour:
minute:
Diagram Options
show angle
show lunar landmark
show time tickmarks
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A Short Note About Think-Pair-Share

A questioning in the classroom technique that makes use of a combination of conceptually challenging multiple choice questions, along with systematic classroom feedback designed to increase student-to-student discourse and provide data on students' learning for both you and them.

Crouch, C. H. & Mazur, E. 2001, "Peer Instruction: Ten Years of Experience and Results," *American Journal of Physics*, 69(9), 970, 2001

Development and Application of a Situated Apprenticeship Approach to Professional Development of Astronomy Instructors, Prather, E. E., and Brissenden, G. The Astronomy Education Review, 7(2), 2008

Clickers as Data Gathering Tools and Students' Attitudes, Motivations, and Beliefs on Their Use in this Application, Prather, E. E., Brissenden, G., The Astronomy Education Review, 8 (1), 2009 .

Vote on the **level of discourse** that the question promotes...

NOT the **answer** to the question.

What is the name of the Moon Phase shown at right?

A. Waxing crescent

B. First quarter

C. Third Quarter

D. Waxing Gibbous

E. None of the Above

If the moon is in the waxing gibbous phase today, how many of the moon phases shown above (A-E) would the moon go through during the next 10 days?

A. Only one

B. Two

C. Three

D. More than three

E. None

Around which object does the Moon orbit?

A. Earth

B. Mars

C. Jupiter

D. Saturn

What would the phase of the moon be?

A. Waxing crescent

B. Third Quarter

C. Waxing Gibbous

D. Waning Crescent

E. Waning Gibbous

Effective Multiple Choice Questions

Using multiple choice questions provides an efficient and effective way to assess a wide range of knowledge, skills, attitudes and abilities (Haladyna, 1999).

Consider your answer to these questions about writing multiple-choice questions.

In a multiple-choice question, when is the longest answer the correct answer?

A. Rarely
B. Sometimes
C. It's common for it to be the correct answer, and it's often stuffed with new information that should have gone in the main part of the course but we forgot so now we're putting it in the quiz because we can't possibly leave out the tiniest detail
D. Occasionally

Adapted from: http://blog.cathy-moore.com/2007/08/can-you-answer-these-6-questions-about-multiple-choice-questions/

Consider your answer to these questions about writing multiple-choice questions.

When is it NOT a good idea to avoid negative questions?

A. Never

B. Sometimes

C. Always

D. What?

Adapted from: http://blog.cathy-moore.com/2007/08/can-you-answer-these-6-questions-about-multiple-choice-questions/

Consider your answer to these questions about writing multiple-choice questions.

How often is the correct choice "A"?

A. Usually
B. Frequently
C. Often
D. Almost never, because if **"A"** is the right answer, then the learner doesn't have to read all the other options we spent so much time writing and revising, and where's the return on investment in that?

Adapted from: http://blog.cathy-moore.com/2007/08/can-you-answer-these-6-questions-about-multiple-choice-questions/

Consider your answer to these questions about writing multiple-choice questions.

When is “All of the above” the correct answer?

A. With alarming regularity

B. When we try to cover too much in one question

C. When we use a question to teach instead of assess

D. All of the above

Adapted from: http://blog.cathy-moore.com/2007/08/can-you-answer-these-6-questions-about-multiple-choice-questions/

Consider your answer to these questions about writing multiple-choice questions.

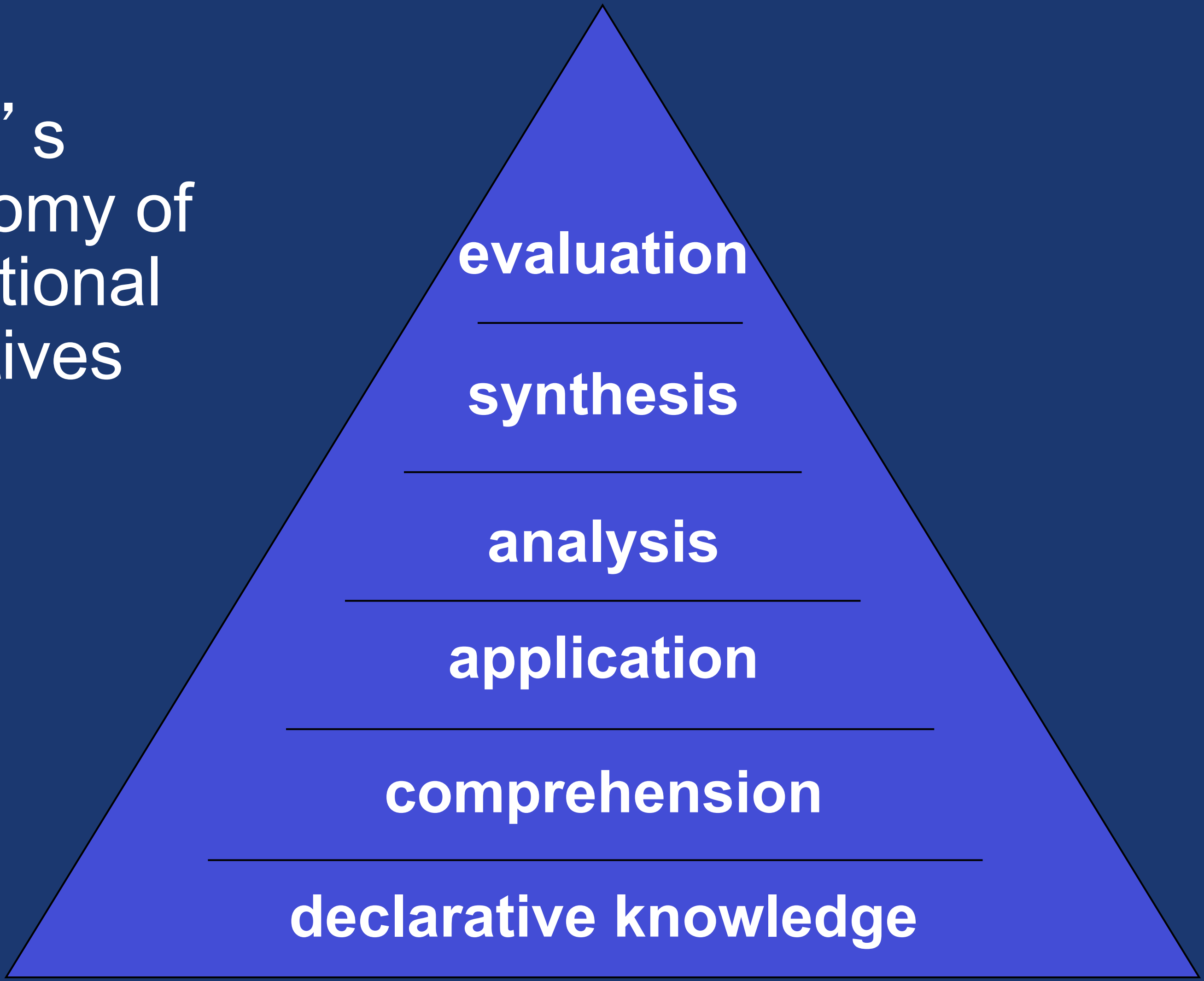
We can confuse learners when we:

A. fail to actually complete the sentence we started in the question.
B. inconsistent grammar in the options.
C. sometimes we veer off into another idea entirely.
D. wombats.

Adapted from: http://blog.cathy-moore.com/2007/08/can-you-answer-these-6-questions-about-multiple-choice-questions/

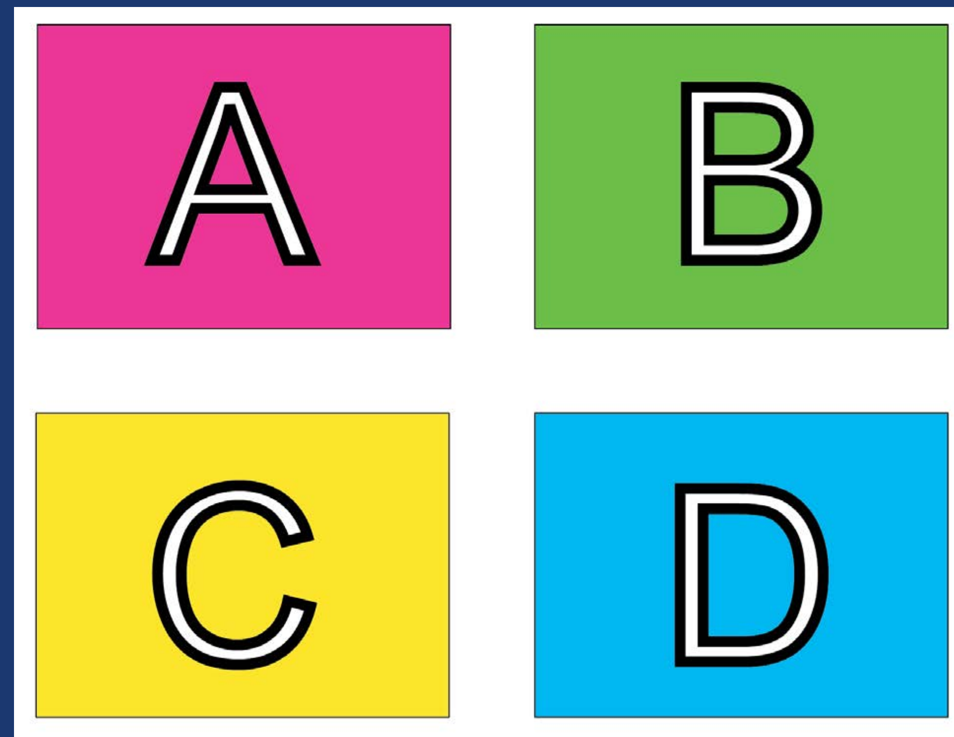
Does your class intellectually engage your students and deepen their conceptual understanding and critical thinking ability or does it re-enforce the memorization of facts and declarative knowledge?

Bloom's Taxonomy of Educational Objectives



The Role of Assessment in the Development of the College Introductory Astronomy Course A "How-to" Guide for Instructors. Astronomy Education Review, 1(1), 1-24, 2002. G. Brissenden, T.F. Slater, and R. Mathieu.

There Are Many Ways to Vote



Which star has the same redshift as star Z for an observer on planet T?

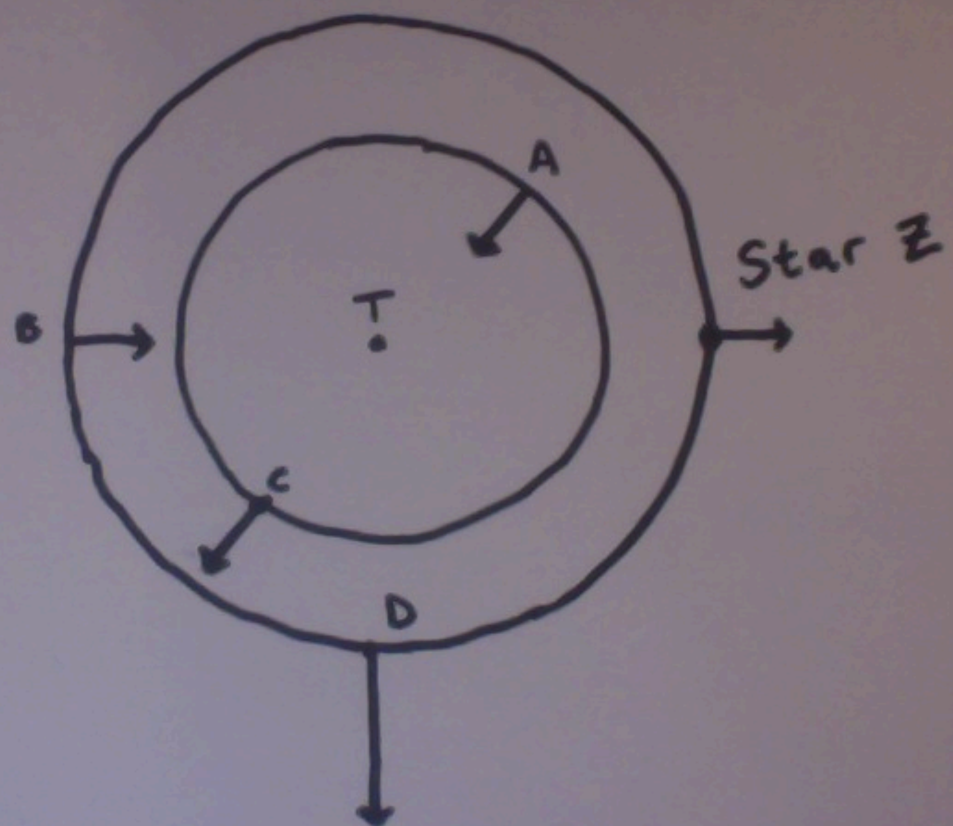
A

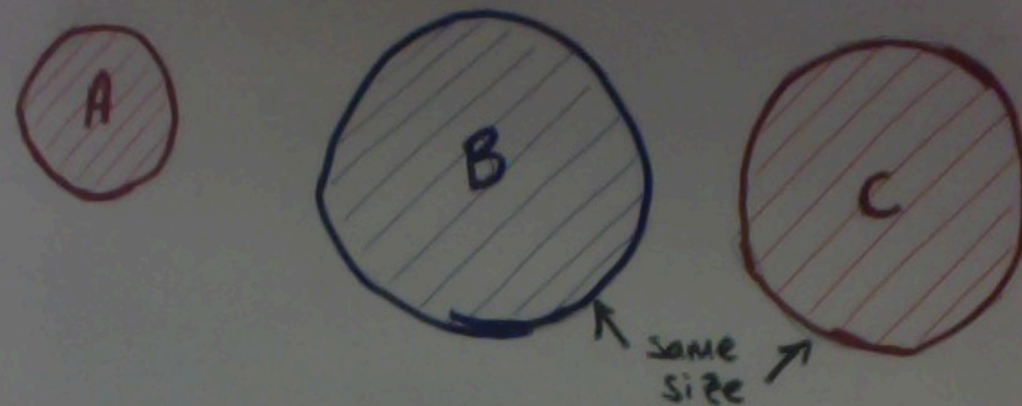
B

C

D

E. None of the above.





Which of the following correctly ranks the luminosity of these stars, from greatest to least?

A) A = C > B

B) C = B > A

C) B > C > A

D) B > C = A

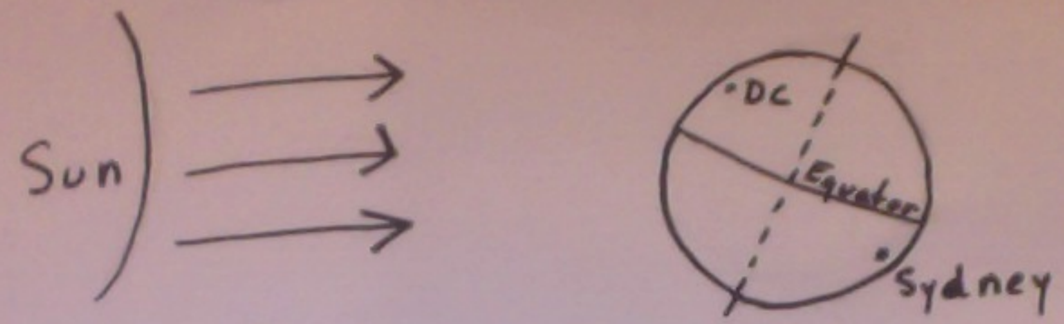
E) A > C > B

Idealized (& shorthand) Implementation of Think-Pair-Share

- Create a cognitively engaging multiple-choice question that challenges students' thinking and has the ability to foster deep discussion amongst your students.
- Present question to students.
- Ask students to "think" individually about the question (and find the best answer).
- Have students anonymously and simultaneously vote on their answer to the question.
- Decide if students should "share" their answers with each other. If so then…
- Ask students to "pair" with someone next to them and to "share" their answers with each other with the goal of trying to convince their partner that their own answer is the correct one.

  "Turn to your neighbor and convince them that you are right, if you have the same answer that does not mean you are right, so be sure to explain your reasoning"
- Again have students anonymously and simultaneously vote on their answer to the question.
- Debrief the results and correct answer to your students.

For greater detail on implementing TPS visit: astronomy101.jpl.nasa.gov/teachingstrategies/teachingdetails/?StrategyID=23 and read Development & Application of a Situated Apprenticeship Approach to Professional Development of Astronomy instructors (Prather & Brissenden, 2008, Astronomy Education Review)



Based on the image above, which of the following is true for Washington D.C. and Sydney, Australia?

A. D.C has longer days and receives less direct sunlight than Sydney.

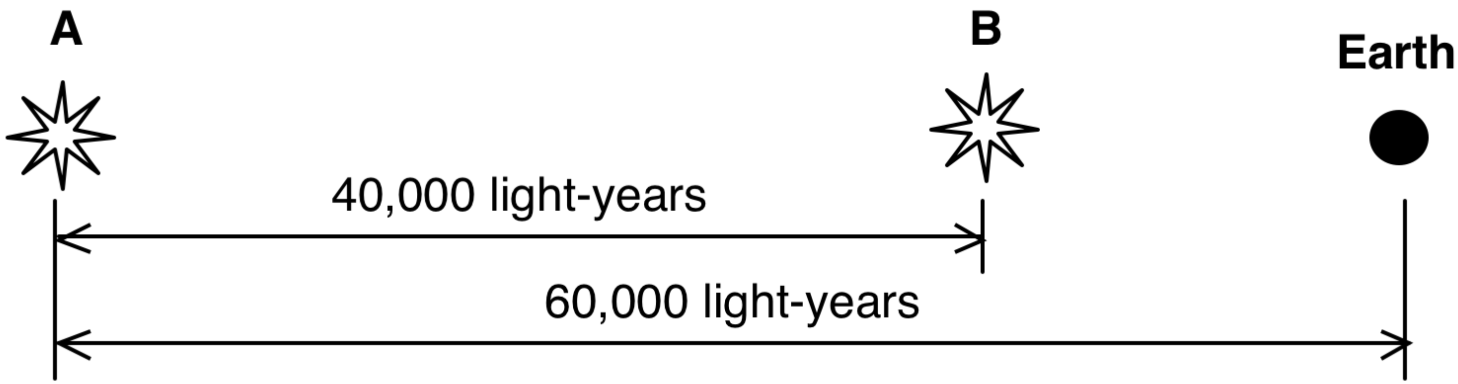
B. Sydney is experiencing shorter days than D.C and is experiencing summer.

C. D.C. is experiencing winter, and Sydney is receiving more direct sunlight than D.C.

D. D.C. is experiencing summer, and Sydney has shorter days than D.C

E. There is not enough information, because distance isn't given.

The drawing below (not to scale) shows Star A, Star B, and Earth all in a line. Star B is 40,000 light-years from Star A, while Earth is 60,000 light-years from Star A. Use this information to answer the next question.



1. When Star A appears 20,000 years old to an observer orbiting Star B, how old would Star A appear to an observer on Earth?
   a. It would be the first day an observer on Earth could see Star A
   b. 20,000 years old
   c. 40,000 years old
   d. 60,000 years old
   e. None of the above are correct.

Preparing for Tomorrow's Implementing Lecture-Tutorials & Ranking Tasks: Your Homework

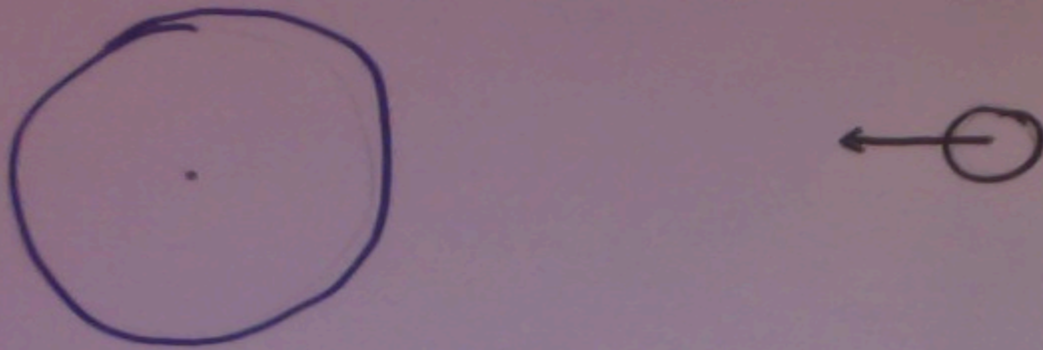
Open your folder, and remove your homework instruction sheet (left side of packet). **Write down your Group Designation (#1b, #2a, #3c, etc.) in the space provided.**

These are POST-lecture activities! If you don't do them yourself—before you use them in class—you won't know what to highlight in your lecture and you may stumble when trying to answer group questions.

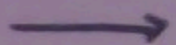
- Do the Lecture-Tutorial/Ranking Task, yourself, modeling your answers after what one of your good students, who truly understood the material, would write.
- Write your answers in English, using words. This is the language your students speak: avoid answering questions by using mathematical symbols and doing calculations.
- While you are working through the activity be mindful of which questions might be a struggle for your students. Which questions are making you struggle? Which are making you use multiple steps of reasoning? Which questions would take you multiple sentences to describe the reasoning for your answer to a non-scientist/ astronomer so that they would understand your reasoning?
- Make notes in the margins of your LT and RT with respect to the previous bullet: What question(s) could you ask a struggling group to help them?

Create a Suitable Question to Use for Think-Pair-Share

- Get in a group of 4
- Step #1, write down the conceptual or reasoning difficulty you believe students have with your topic that your question will address—you will be presenting this after you implement your question.
- Step #2, write your TPS question. Be sure to write clearly and create all graphs and diagrams needed for the question so it can be presented on a single sheet of paper.
- Step #3, determine how each member of your group will play a role when implementing TPS using your question.



A. 

B. 

C. 

D. 

Consider the Earth and Moon. In the diagram, the force of the Earth on the Moon is shown.

Identify the arrow best representing the force of the Moon on the Earth.

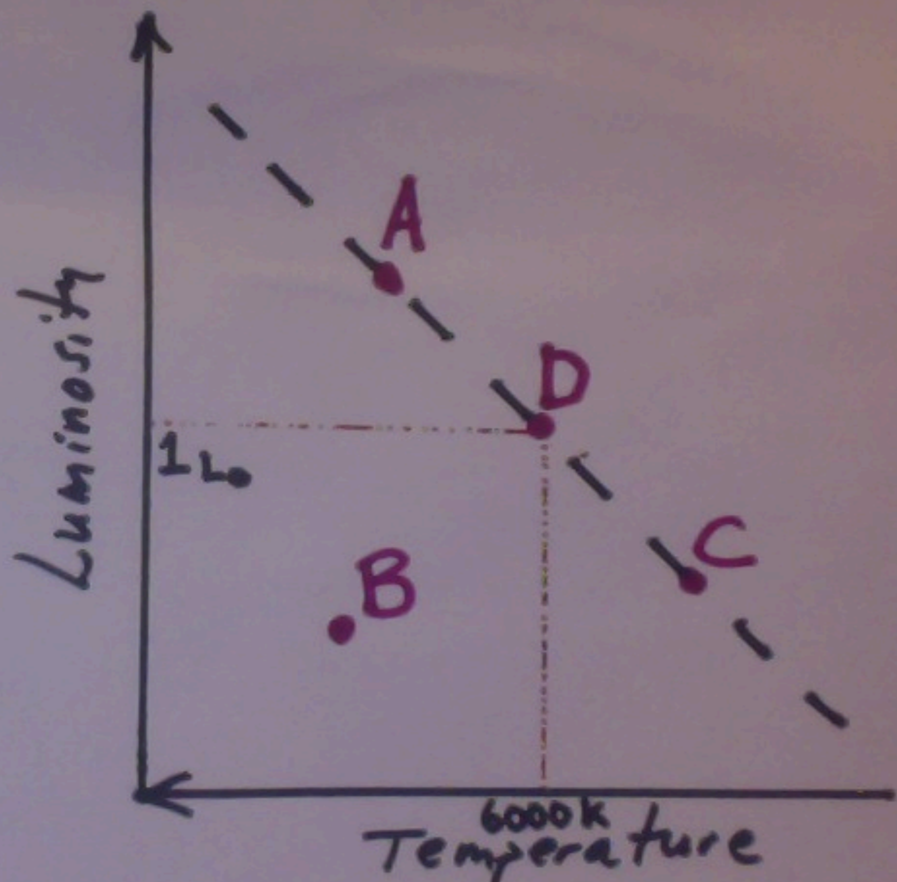
Rank, from greatest to least, the fusion rate of these stars:

A) B, A, D, C

B) C, D, A, B

C) A, D, C, B

D) A = B = C = D



Let the Teaching Begin: Think-Pair-Share

A Short Note About Think-Pair-Share:

A questioning in the classroom technique that makes use of a combination of conceptually challenging multiple choice questions, along with systematic classroom feedback designed to increase student-to-student discourse and provide data on students' learning for both you and them.

Crouch, C. H. & Mazur, E. 2001, "Peer Instruction: Ten Years of Experience and Results," *American Journal of Physics*, 69(9), 970, 2001

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How to TPS?

Take 5 minutes to respond to the following:

- Describe every step in successful implementation of TPS.

Think-Pair-Share Implementation Question:

- Why would you choose to incorporate Think-Pair-Share into your existing course?
- How do you motivate students to participate in Think-Pair-Share—at the beginning of your course and throughout the semester?
- How do you get students who are not participating to do so—and how would you know if they're not participating?
- Why does it matter if students talk with each other during the "sharing" phase?
- How do you construct a Think-Pair-Share question—what are the necessary components?
- When should you read the question to your students?
- When should you share with your students the result of the first vote?
- When should you have students "share" their vote and reasoning with each other?
- What can you say to your students to quickly and earnestly get them talking to each other during the "share" phase?
- What can you do to decide if you've given them enough time—to have decided on their first vote, to have talked with each other before the second vote?
- What can you do to stop their "sharing" and focus back on you?
- How can you project to each student that the question is fair and reasonable?
- When should you tell them the correct answer?
- What are some ways you can debrief the correct answer to the question?

What Can I do Besides Lecture to Engage Students in their Learning?

- Ask students questions (not all questions are equal)
- Use interactive videos, demonstrations, animations, and simulations
- In-class writing (with or without discussion)
  - Muddiest Point
  - Summary of Today's Main Points
  - Writing Reflections
- Think-Pair-Share or Peer Instruction
- Small Group Interactions
  - Concept Maps
  - Case Studies
  - Sorting Tasks
  - Ranking Tasks
  - Lecture-Tutorials
- Student Debates (individual/group)
- Whole Class Discussions

A Short Note About Lecture-Tutorial

Post-lecture, pencil and paper activities, that use a Socratic-dialogue driven, highly-structured collaborative learning methodology to help students elicit, confront and resolve their naïve beliefs and reasoning difficulties, and develop scientifically robust conceptual models.

A Short Note About Ranking Tasks

Post-lecture, pencil and paper activities, that again make use of a highly-structured collaborative learning methodology which presents learners with a series of pictures or diagrams that describe slightly different variations of a basic physical situation. The student is asked to make a comparative judgment of each situation and either sort or identify the order or ranking of the various situations based on some physical outcome or result.

Idealized Classroom Implementation of Small Group Activities

- Professor lectures for approximately 20 minutes on core ideas needed to do the activity.
- To motivate the need to do the activity, students are given a conceptually challenging questions on the presented lecture material which is just beyond students current ability but representative of what they will see on the test.
- Class is divided into pairs or small groups and instructed to work collaboratively and reach consensus on the questions presented in the activity.
- Instructor circulates through the room listening to student conversations but does not interact with groups unless hands are raised.
- Instructor provides time announcements approximately every 5-8 minutes per page.
- When approximately 60% of students are on last page, instructor asks students to "raise their hand if they are on the last page or done", and then state "You've got about two more minutes."
- Instructor debriefs the activity interactively, highlighting common student conceptual and reasoning difficulties with select questions.
- Instructor asks students another "test day" conceptual questions to demonstrate what they will be held accountable for on their test, to demonstrate the power of having done the activity, and to highlight what students might need to study more.
- Instructor returns to lecture mode on next course topic.

Student Instructions

- Work with a partner.
- Read the instructions and questions carefully, word-for-word.
- Talk to each other and discuss your answers with one another.
- Come to a consensus answer you both agree on BEFORE you write down your answer.
- If you get stuck or are not sure of your answer ask another group.
- If you get really stuck or don't understand what the activity is asking, ask one of us for help.

Tutorial: Luminosity, Temperature, & Size
p. 55 (in packet)

- Work with a partner.
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Let the Acting Begin: Vignettes of Implementation

Find your teacher partner (i.e. 1a, 2c, etc…)

- Review homework
  - Notes about student difficulties
  - Reasoning steps
  - Questions you can ask students who are struggling

Let’s Try Implementing Small Group Activities

- Teachers #1, go to the back of the room & with your teacher partner
- The rest of you, get into groups of 2 (3 if you must)—you will be GOOD “students”!
- We’ll rotate…

Students:

- This is a POST-lecture activity.
- You have a GOOD instructor.
- Their lecture adequately prepared you to do the activity.
- DO NOT get stuck on the first question and act as if it is impossible for you to understand the content.
- DO ask a question that a GOOD student will have while trying to learn this content.
  - You must discuss with your partner what you believe a student would actually have a reasoning difficulty about before you raise your hand!
- Challenge yourself to speak in ONLY EASS gen. ed. students language

Teachers:

- Listen to the conversation your students are having.
- Keep track of the time, and provide a time announcement.
- When your students raise their hands, first ask them to read you the question
- Resists telling them information or giving them a mini-lecture: This is a POST-lecture activity.
- Think of questions you can ask to help them move forward.
  - Discuss with your partner your ideas about how to best address their reasoning difficulty.
- This is your chance to learn how to stay in the Socratic dialogue.
- Don't forget to keep track of time and provide time stamps.

A Short Note About Lecture-Tutorial

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Post-lecture, pencil and paper activities, that again make use of a highly-structured collaborative learning methodology which presents learners with a series of pictures or diagrams that describe slightly different variations of a basic physical situation. The student is asked to make a comparative judgment of each situation and either sort or identify the order or ranking of the various situations based on some physical outcome or result.

Implementing Small Group In-Class Activities

- Why would you choose to incorporate in-class activities into an existing course?
- How do you motivate students to do in-class activities—at the beginning of your course and throughout the semester?
- Why does it matter if the students talk to each other and come to consensus?
- What do you need to do, prior to creating your lecture, so that you create an effective PRE-activity lecture? What should your lecture include? What should your lecture not include?
- What do you do while your students are doing the in-class activity?
- How do you manage and communicate time limits while students are doing your in-class activities
- How do you estimate how long the activity will take?

Implementing Small Group In-Class Activities

- When/Why should you ask a group member to read the question they are working on aloud to you?
- When/Why should you answer a group's question with another question?
- When/Why should you ask one member of a group what the other student in their group wrote or what they were thinking when they wrote their answer?
- When/Why should you pause the entire class to discuss a particular question?
- When/Why should you ask your students to work with a different partner?
- What do you do with a group that is clearly not working together?
- What do you do with a group of students that is not even working?

Implementing Small Group In-Class Activities

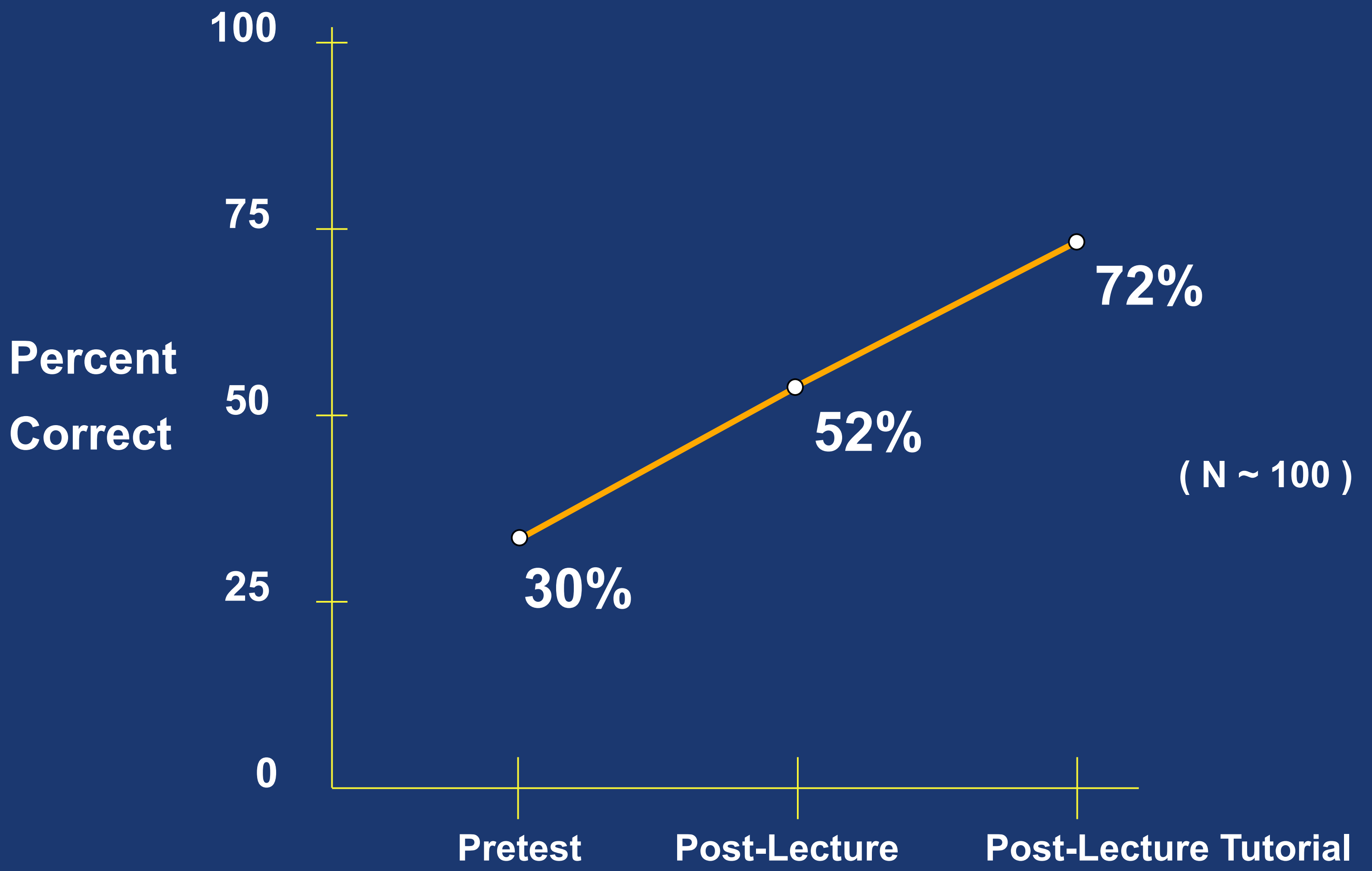
- Is it okay to end the in-class activities even if everyone is not done?

- What are effective and in-effective ways to debrief in-class activities?

- How do you make your students realize what activity content they are accountable for on the exam and whether or not they need to do some more studying?

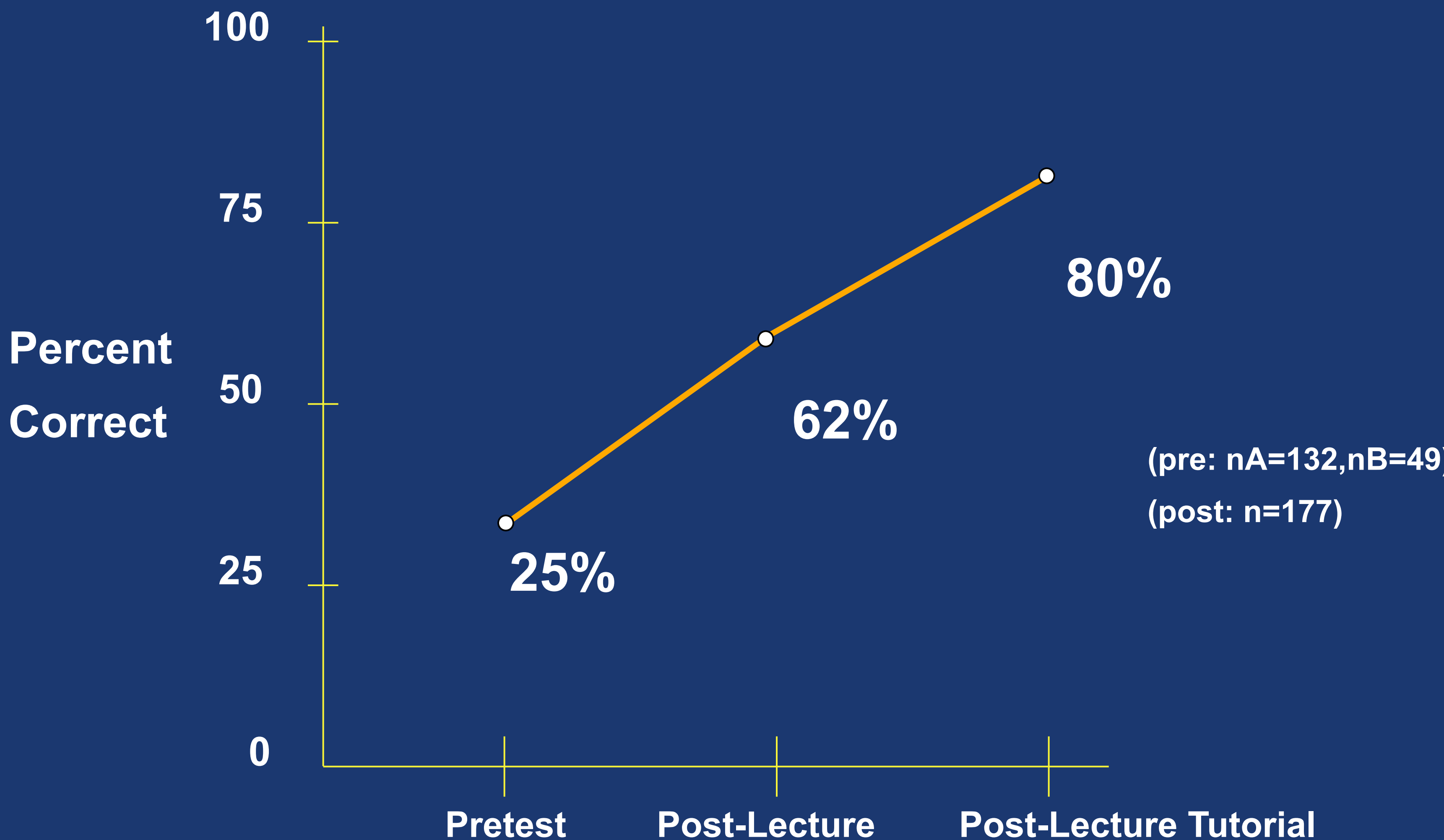
- When or why should you, or should you not, provide solutions to in-class activities?

The Results from our Research to Validate the Effectiveness of Lecture-Tutorials: Using Scantrons.



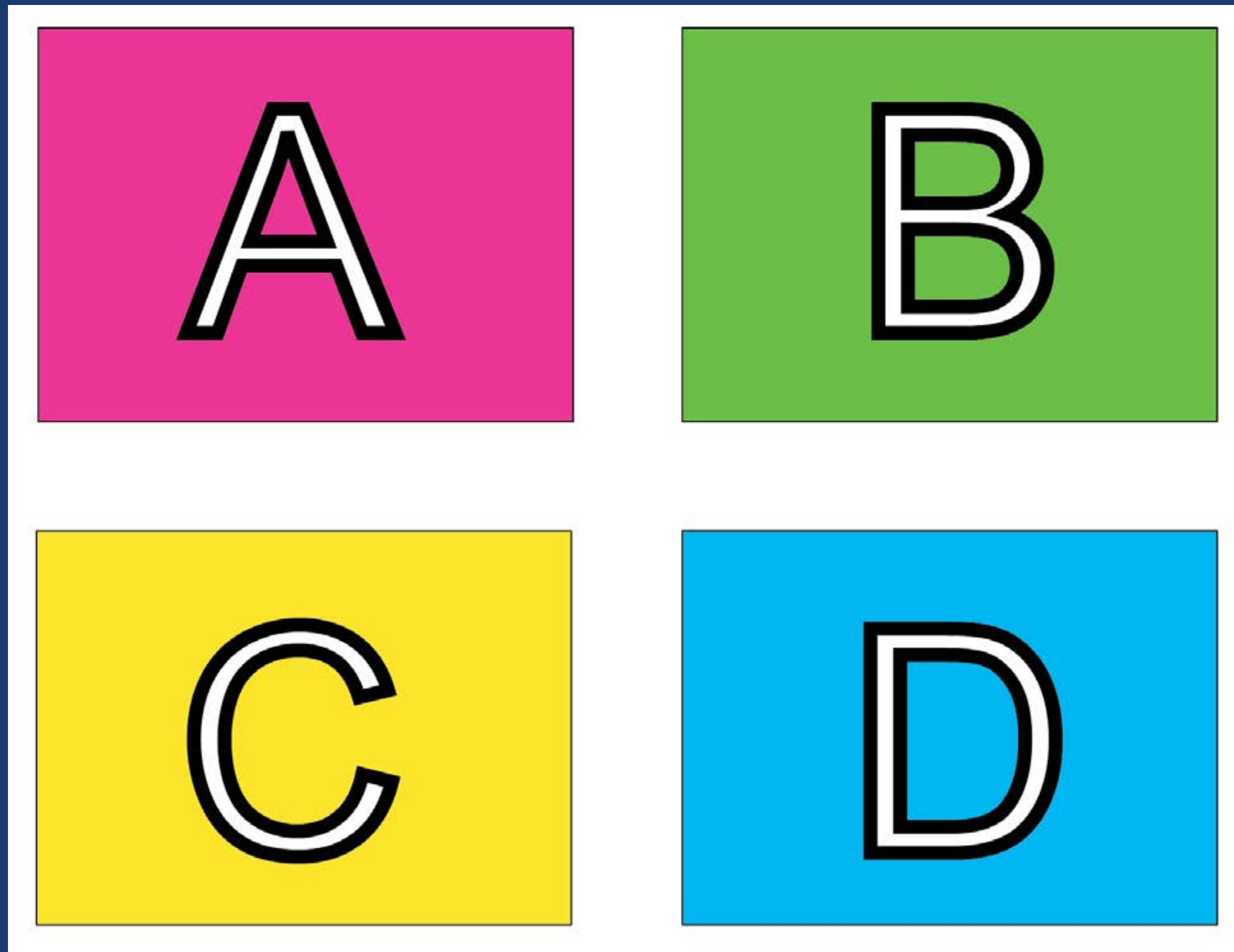
Research on a Lecture-Tutorial Approach to Teaching Introductory Astronomy for Non–Science Majors, Prather, E. E.; Slater, T. F.; Adams, J. P.; Bailey, J. M.; Jones, L. V.; Dostal, J. A., Astronomy Education Review, 3(2) 2005

The Results from our Research to Validate the Effectiveness of Lecture-Tutorials: Using Clickers.



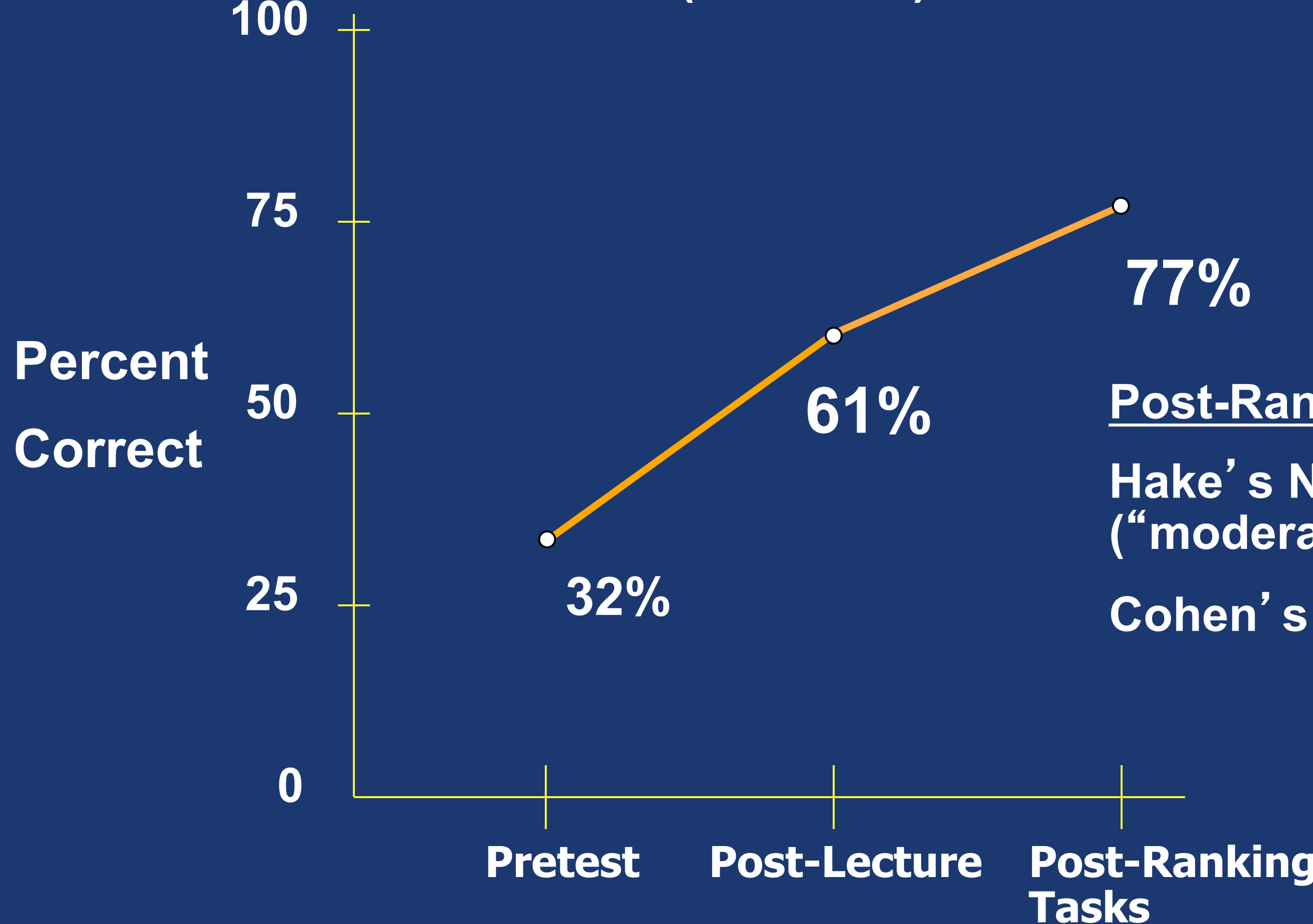
Clickers as Data Gathering Tools and Students' Attitudes, Motivations, and Beliefs on Their Use in this Application, Prather, E. E., and Brissenden, G., Astronomy Education Review, 8(1), 2009.

The Results from our Research to Validate the Effectiveness of Lecture-Tutorials: Using Cards.



The Results from our Research to Validate the Effectiveness of Ranking Tasks

(N ~ 100)



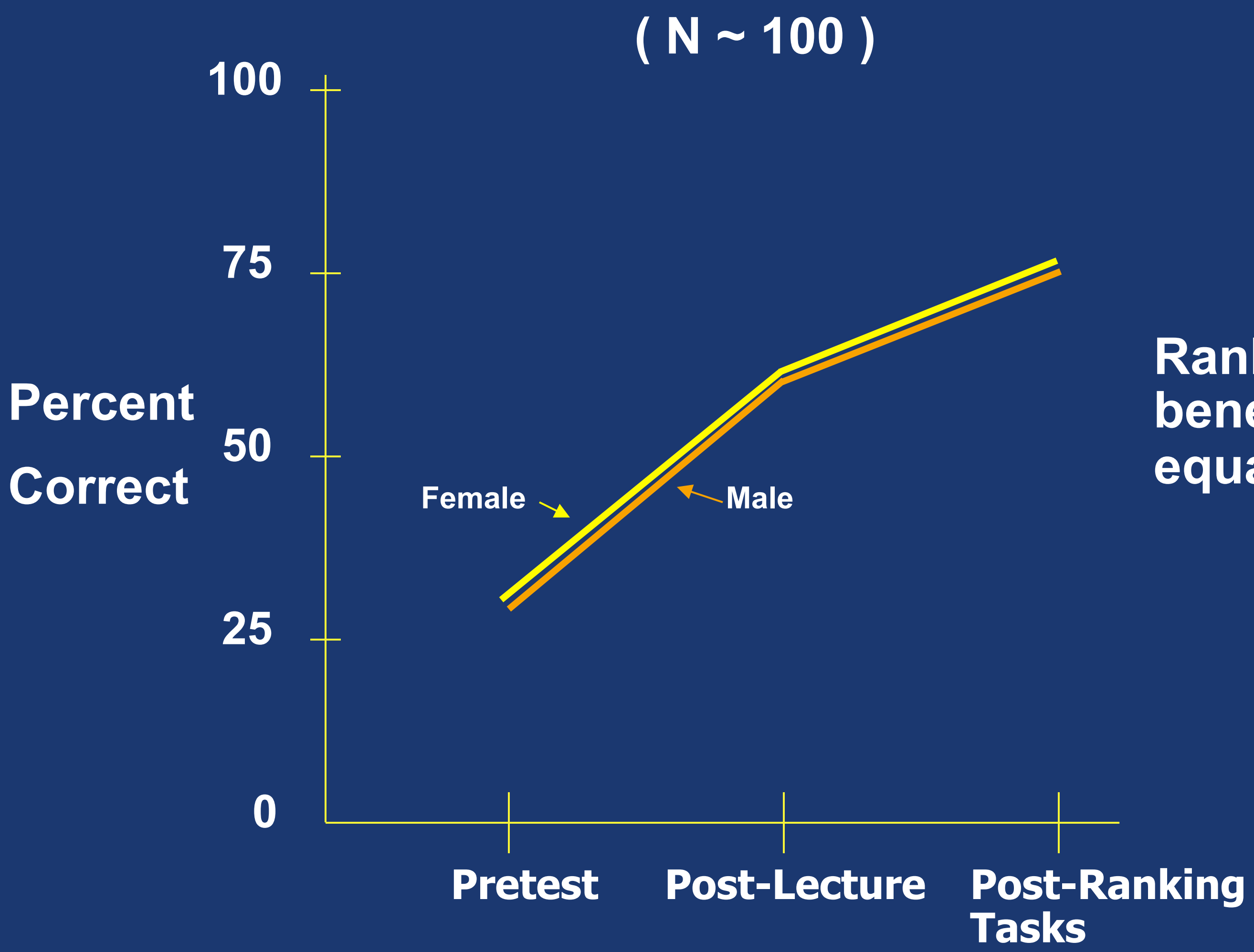
<u>Post-Ranking Task:</u>

Hake's Normalized Gain = 0.41 ("moderately large effect")

Cohen's d = 0.62 ("Large effect")

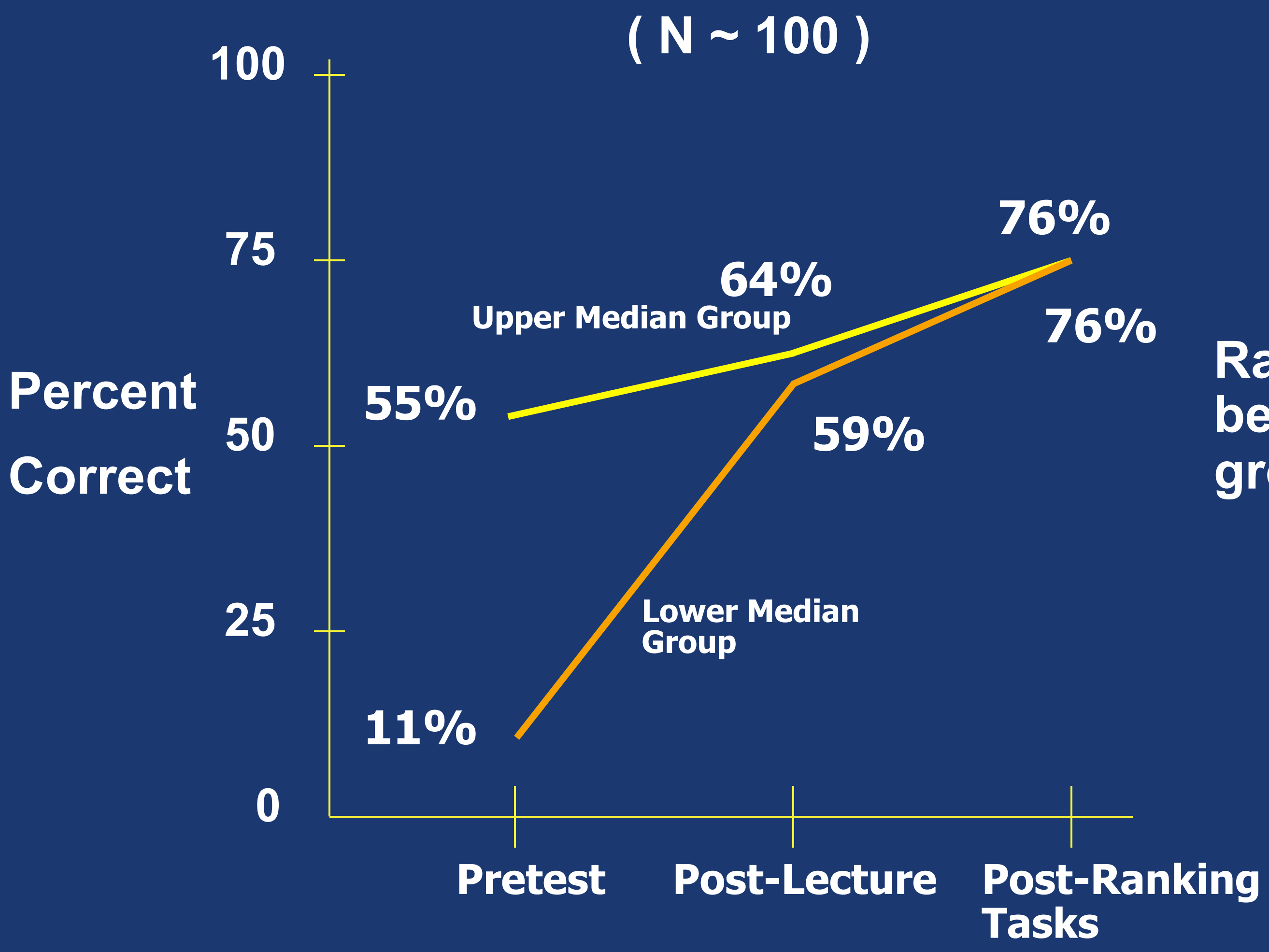
Effectiveness of Collaborative Ranking Tasks on Student Understanding of Key Astronomy Concepts, Hudgins, D. W., Prather. E. E., Grayson, D.J. and Smits, D. P. <u>Astronomy Education Review</u>, 5(1), 2006

Ranking Tasks: Gender Effect?



Ranking Tasks benefited both groups equally.

Ranking Tasks: High vs. Low Pretests Groups?



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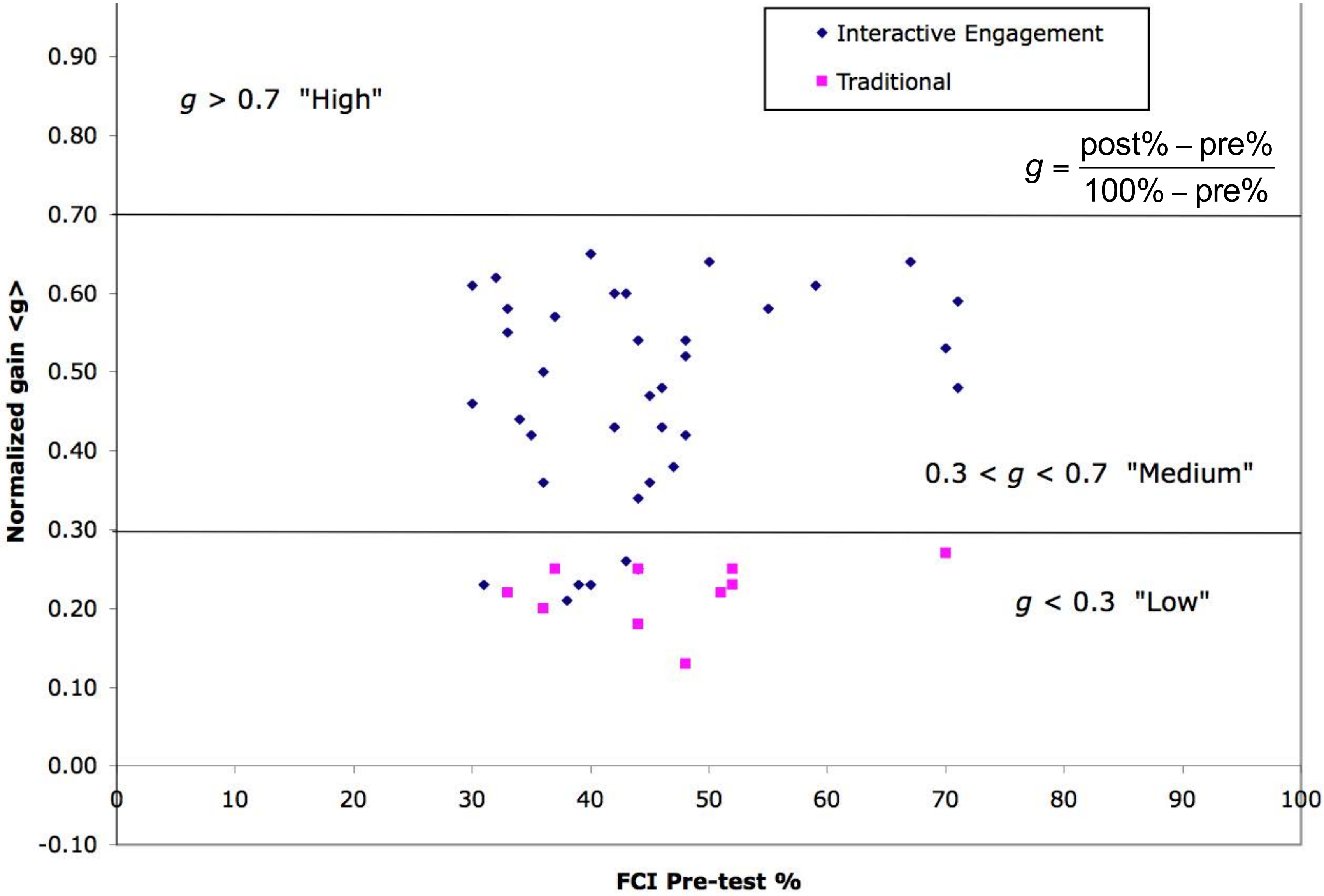
Results from a 6000 student study of Physics Students – *Hake AJP 1998*



R. Hake, "…A six-thousand-student survey…" AJP 66, 64-74 (1998).

CAE National Study

- Almost 4000 students
- 31 institutions
- 36 instructors
- 69 different sections
  - Section sizes vary from <10 to 180 (now with sections >750!)

This was a truly national study

CAE National Professional Development Program

CAE
Center for Astronomy Education
» Dedicated to the professional development of introductory astronomy instructors

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Workshops

Teaching Excellence Workshops

Workshops Locations
Click a location to register for a specific workshop

Fall/Winter 2010/11

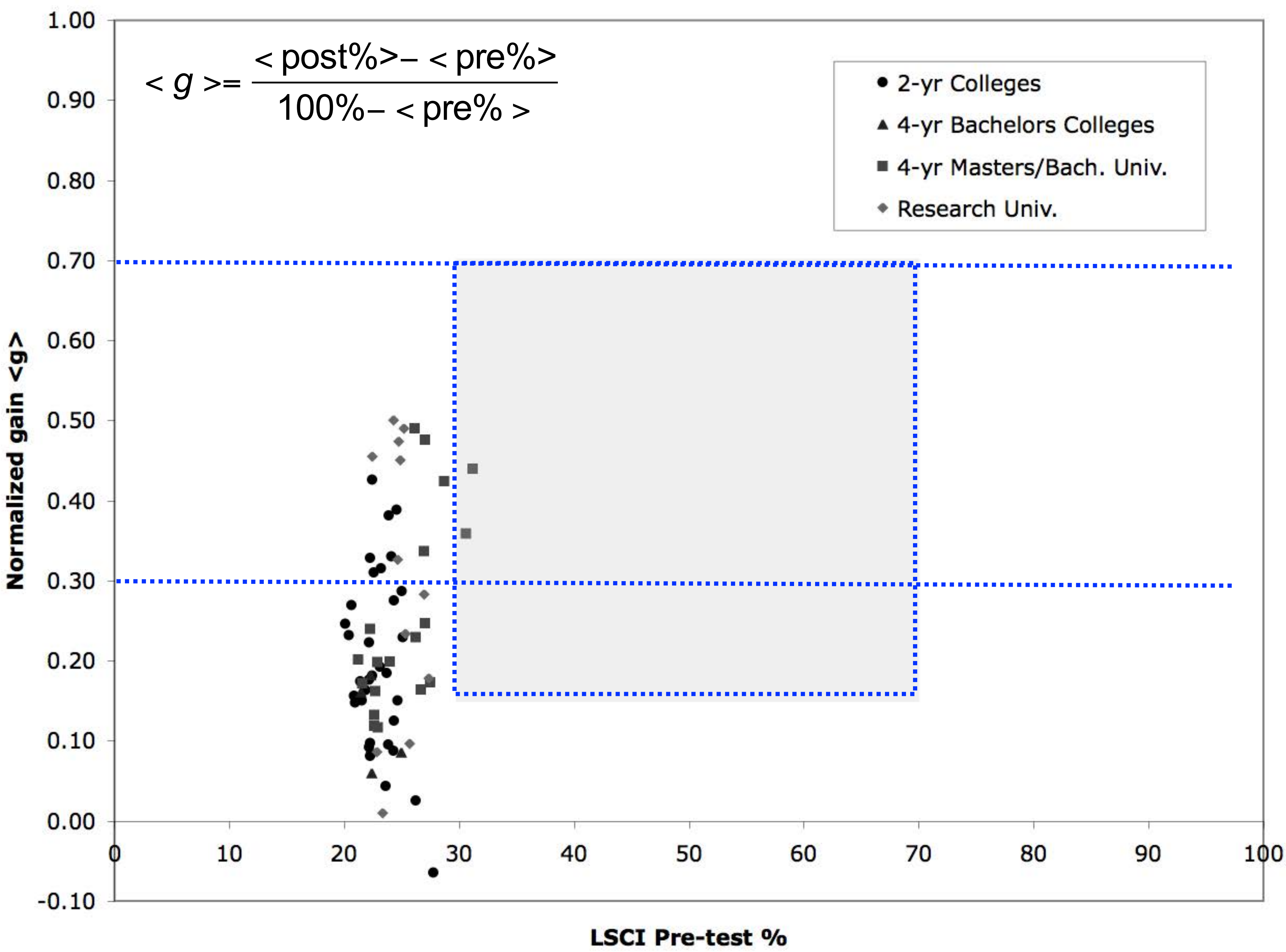
1. Oberlin, OH
   Tier I
   September 18-19, 2010
2. Dearborn, MI
   Regional Teaching Exchange
   October 01 - 02, 2010
3. Seattle, WA
   Tier I,CATS
   January 8-9, 2011
4. Seattle, WA
   Tier II,CATS,Special Topics
   January 9, 2011
5. Plano, TX
   Regional Teaching Exchange
   February 12, 2011
6. State College, PA
   Tier I

Spring/Summer 2011

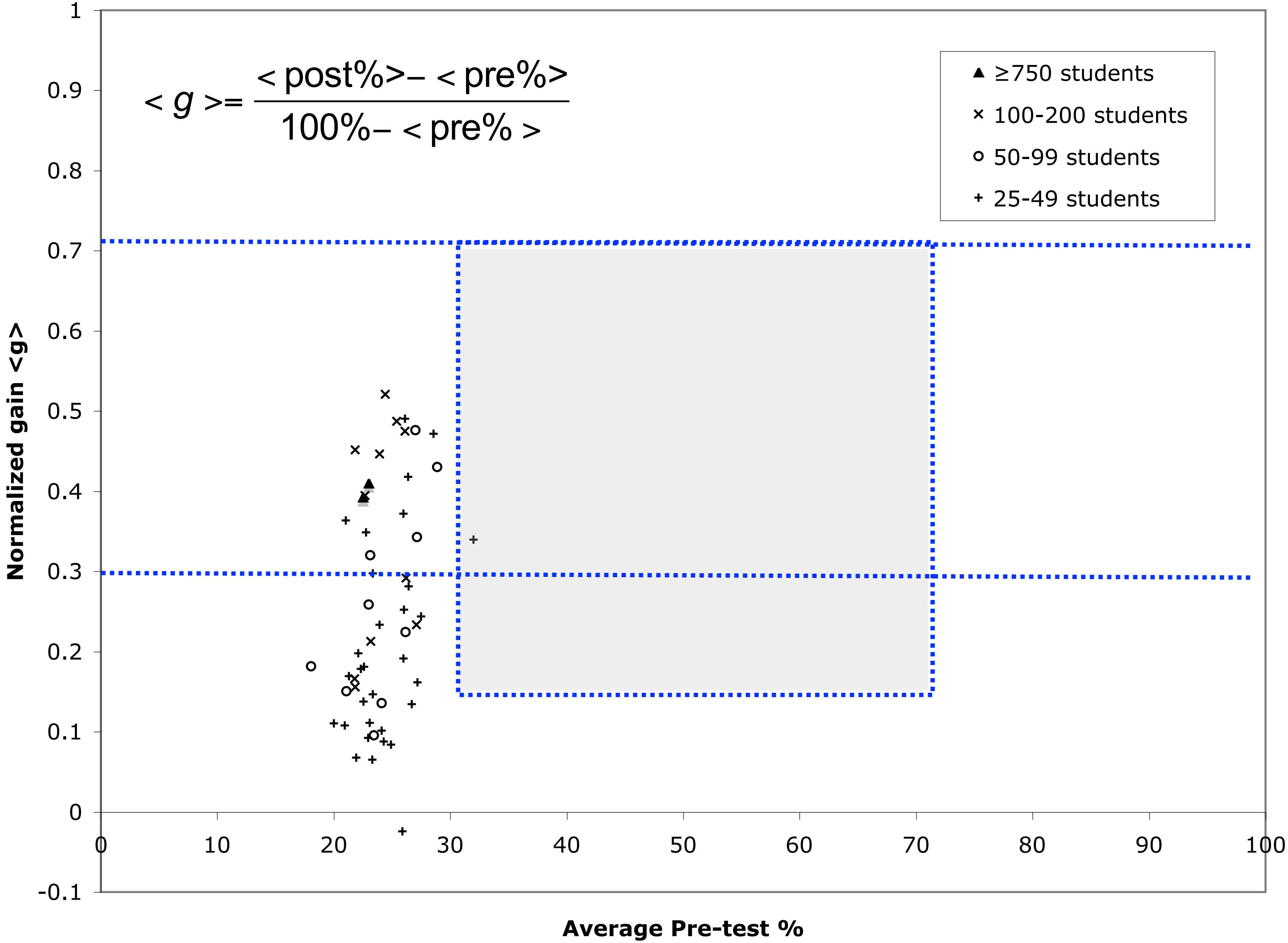
7. New Paltz, NY
   CATS,Regional Teaching Exchange
   March 26, 2011
8. El Paso, Texas
   Tier I
   April 15 - 16, 2011
9. Seattle, WA
   CATS,Regional Teaching Exchange
   April 16, 2011
10. Oceanside, California
    Regional Teaching Exchange
    May 7, 2011
11. Boston, MA
    Tier I,CATS
    May 21 & 22, 2011

Fall/Winter 2011/12

15. Austin, TX
    Tier I,CATS
    January 7-8, 2012
16. Austin, TX
    Tier II,CATS,Special Topics
    January 8, 2012



$$\langle g \rangle = \frac{\langle post\% \rangle - \langle pre\% \rangle}{100\% - \langle pre\% \rangle}$$
2-yr Colleges
4-yr Bachelors Colleges
4-yr Masters/Bach. Univ.
Research Univ.
Normalized gain <g>
LSCI Pre-test %
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0
10
20
30
40
50
60
70
80
90
100

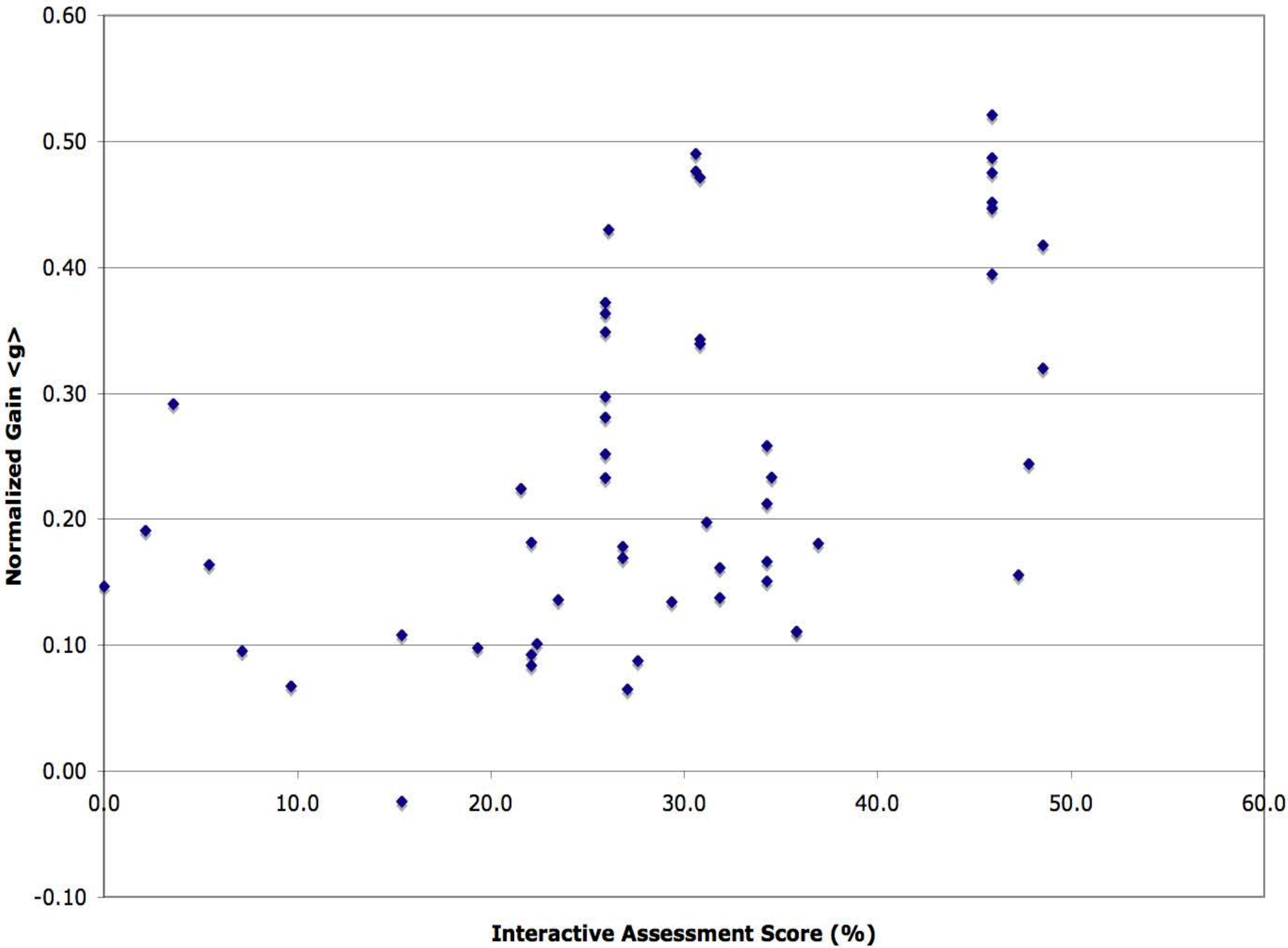


$$< g >= \frac{< post\% > - < pre\% >}{100\% - < pre\% >}$$
≥750 students
100-200 students
50-99 students
25-49 students
Normalized gain <g>
Average Pre-test %
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
0
10
20
30
40
50
60
70
80
90
100

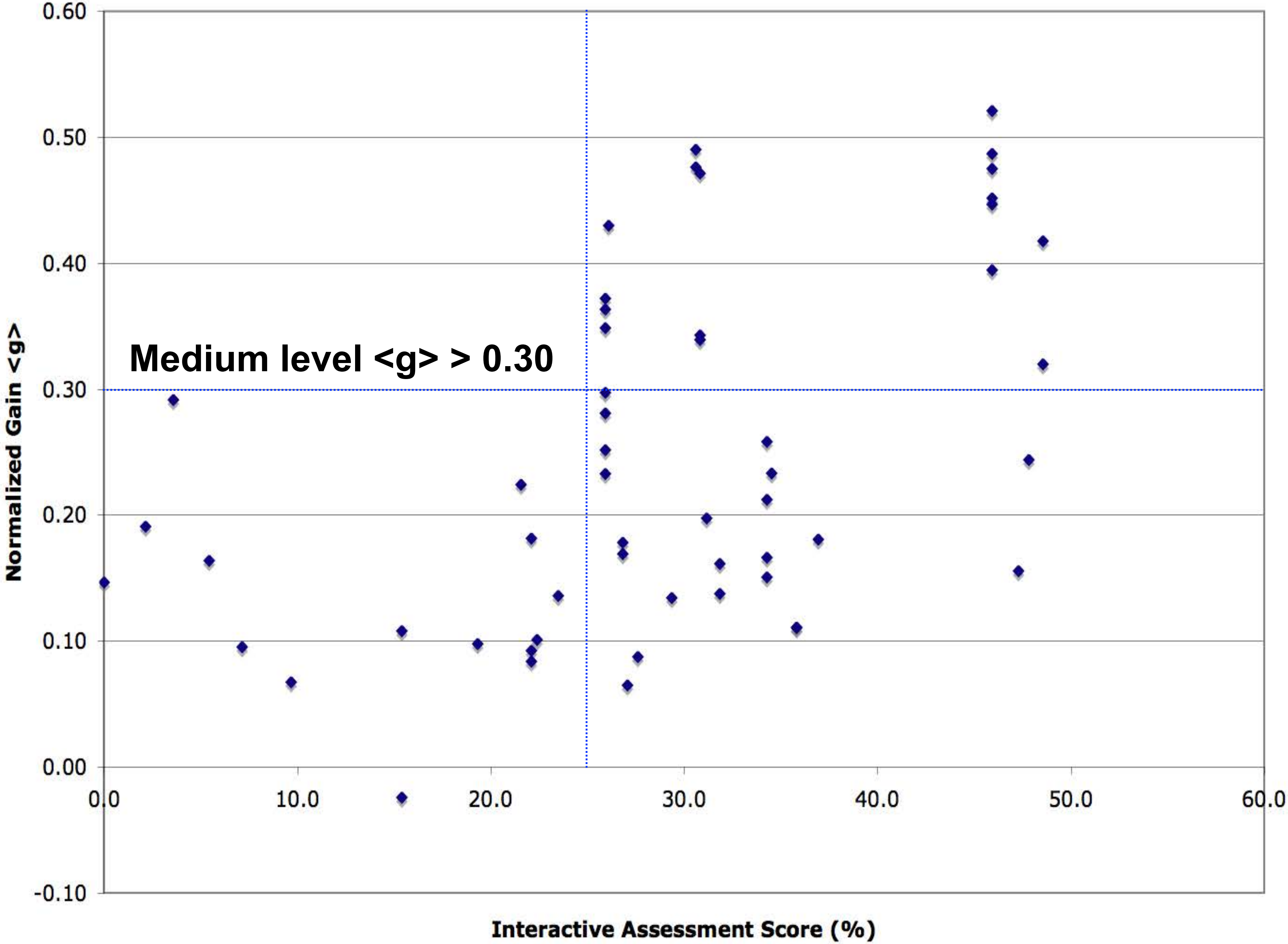
Instructor Surveys

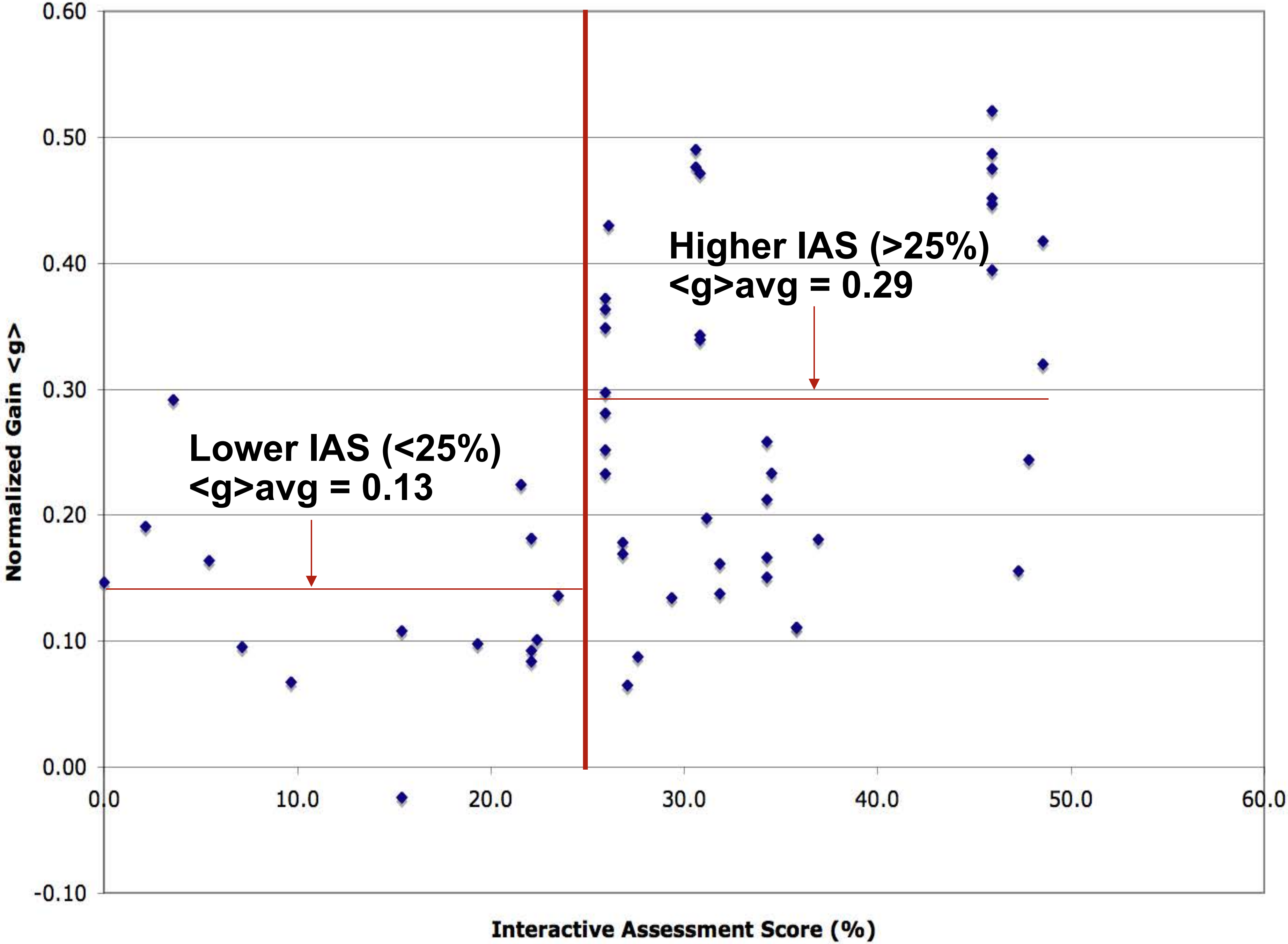
- To assess the level of interactivity in each classroom, we asked each instructor to fill out a survey detailing how they spent their class time

- This survey was used to construct an "Interactivity Assessment Score" (IAS) based on what percentage of total class time is used for interactive activities



Normalized Gain <g>
Interactive Assessment Score (%)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.0
10.0
20.0
30.0
40.0
50.0
60.0


Medium level <g> > 0.30
Normalized Gain <g>
Interactive Assessment Score (%)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.0
10.0
20.0
30.0
40.0
50.0
60.0



Higher IAS (>25%)
<g>avg = 0.29
Lower IAS (<25%)
<g>avg = 0.13
Normalized Gain <g>
Interactive Assessment Score (%)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0.0
10.0
20.0
30.0
40.0
50.0
60.0

Demographic Survey

- We also asked 15 demographic questions to allow us to determine how such factors as
  - Gender
  - Ethnicity
  - English as a native language
  - Parental education
  - Overall GPA
  - Major
  - Number of prior science courses
  - Level of mathematical preparation

  interact with instructional context to influence student conceptual learning
- This survey also gives us a snapshot of who is taking Astro 101 in the US

- We conducted a full multivariate modeling analysis of our data

- We confirm that the level of interactivity is the *single most important variable* in explaining the variation in gain, even after controlling for all other variables

	Normalized Gain							
	1		2		3		4	
Independent Variable	Coefficients (standard error)	Standardized Coefficients	Coefficients (standard error)	Standardized Coefficients	Coefficients (standard error)	Standardized Coefficients	Coefficients (standard error)	Standardized Coefficients
Constant	-0.070 (0.059)		-0.235** (0.060)		-0.266* (0.120)		-0.208** (0.061)	
Male	0.093** (0.016)	0.183**	0.087** (0.015)	0.170**	0.085* (0.038)	0.167*	0.087** (0.015)	0.171**
White	0.019 (0.020)	0.032	0.012 (0.020)	0.020	0.033 (0.055)	0.055	0.013 (0.019)	0.021
Native English speaker	0.019 (0.029)	0.022	0.013 (0.028)	0.015	-0.049 (0.080)	-0.057	0.011 (0.028)	0.013
Father with Bachelor's degree or higher	0.008 (0.016)	0.015	0.004 (0.016)	0.008	0.004 (0.016)	0.008	0.005 (0.016)	0.009
Natural log of Family Income	0.002 (0.010)	0.008	0.002 (0.009)	0.008	0.002 (0.009)	0.006	0.003 (0.009)	0.008
Class year	0.018* (0.008)	0.071*	0.024** (0.008)	0.092**	0.024** (0.008)	0.093**	0.024** (0.008)	0.093**
College GPA	0.036** (0.010)	0.106**	0.037** (0.010)	0.109**	0.067** (0.026)	0.197**	0.036** (0.010)	0.106**
Arts, Humanities, or Social Science major	0.101** (0.018)	0.176**	0.104** (0.017)	0.181**	0.010 (0.042)	0.018	0.023 (0.041)	0.040
Last math class taken	0.031** (0.005)	0.214**	0.034** (0.005)	0.230**	0.040** -0.011	0.274**	0.034** (0.005)	0.229**
Number of previous physical science course	0.024** (0.006)	0.120**	0.024** (0.006)	0.120**	0.021 (0.015)	0.105	0.023** (0.006)	0.119**
Previous Astrophysics course	-0.029 (0.022)	-0.039	-0.028 (0.022)	-0.039	-0.031 (0.022)	-0.042	-0.030 (0.022)	-0.041
Pretest Percent Correct	-0.005** (0.001)	-0.224**	-0.005** (0.001)	-0.213**	-0.005** (0.001)	-0.213**	-0.005** (0.001)	-0.212**
Interactivity Score			0.0051** (0.0006)	0.258**	0.0062 (0.0037)	0.314	0.0043** (0.0007)	0.217**
Cross term: Interactivity score X Arts, Humanities, Soc Sci Major					0.0032* (0.0013)	0.183*	0.0027* (0.0013)	0.158*
Cross term: Interactivity score X Male					0.0001 (0.0012)	0.004		
Cross term: Interactivity score X White					-0.0006 (0.0018)	-0.044		
Cross term: Interactivity score X Native English speaker					0.0022 (0.0027)	0.129		
Cross term: Interactivity score X College GPA					-0.0010 (0.0008)	-0.182		
Cross term: Interactivity score X Last math class taken					-0.0002 (0.0004)	-0.057		
Cross term: Interactivity score X Number of previous physical science courses					0.0001 (0.0005)	0.016		
F Value	*18.2***		*24.3***		*16.2***		*23.0***	
N	*910*		*910*		*910*		*910*	
Adjusted R-Square	*0.185*		*0.250*		*0.250*		*0.253*	

***p < .05**
****p < .01**

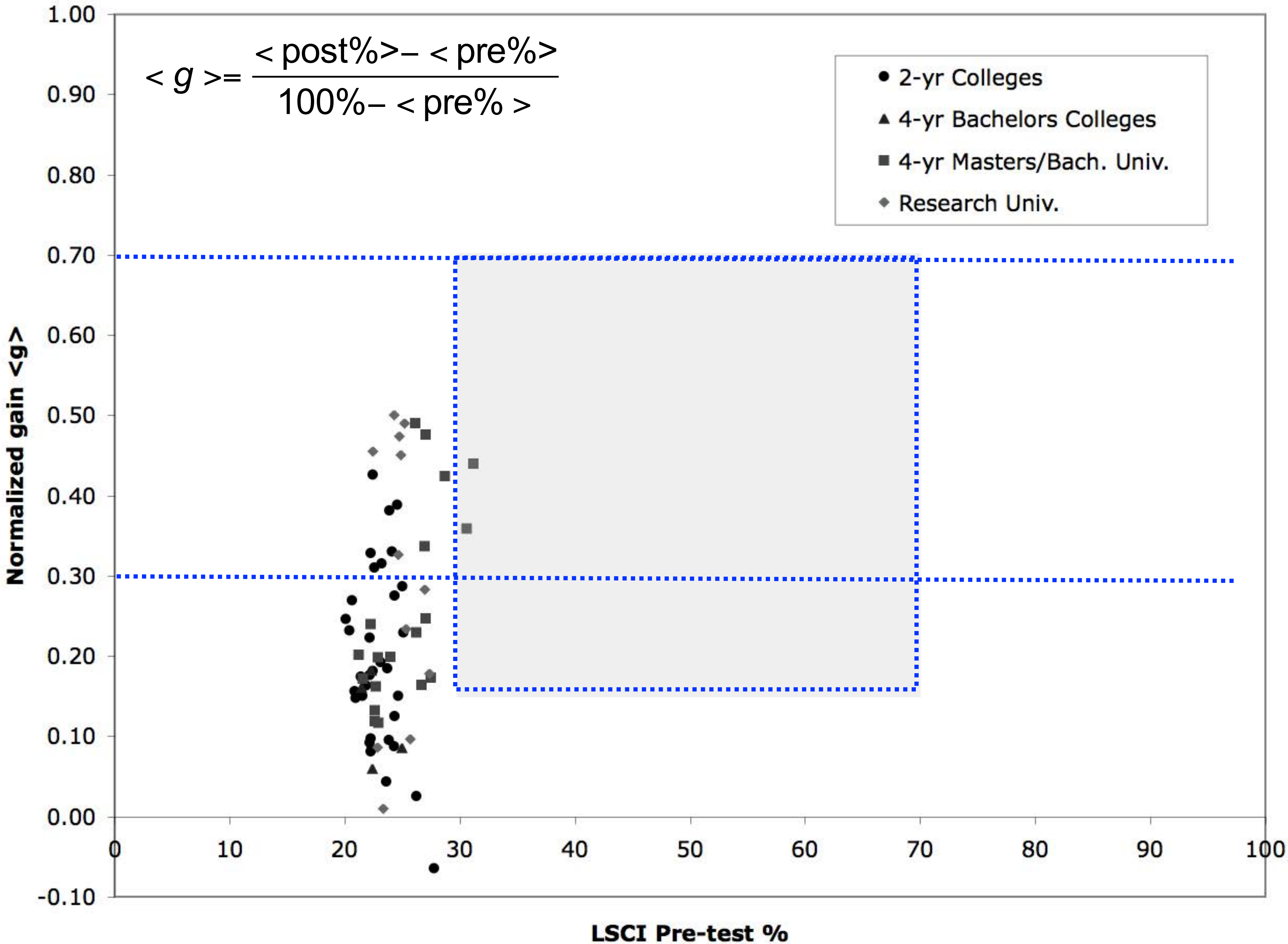
The take home message Part I:

The results of our investigation reveal that the positive effects of interactive learning strategies apply equally to men and women, across ethnicities, for students with all levels of prior mathematical preparation and physical science course experience, independent of GPA, and regardless of primary language. These results powerfully illustrate that all categories of students can benefit from the effective implementation of interactive learning strategies.

The take home message Part II

Implementation is the most important factor to success in student learning.

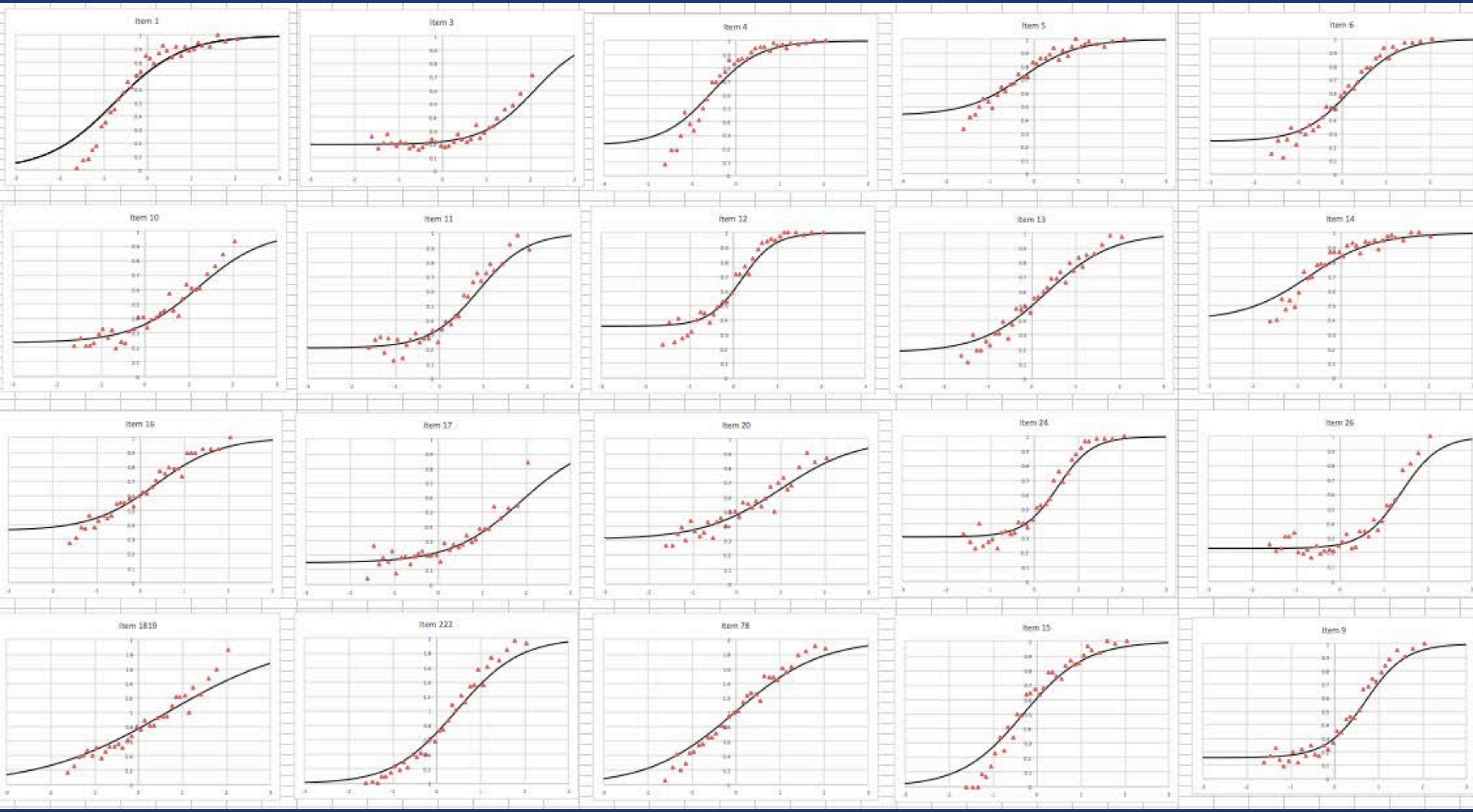
More work on professional development of faculty is needed if we are to see wide spread adoption and proper implementation of research-validated instructional strategies.

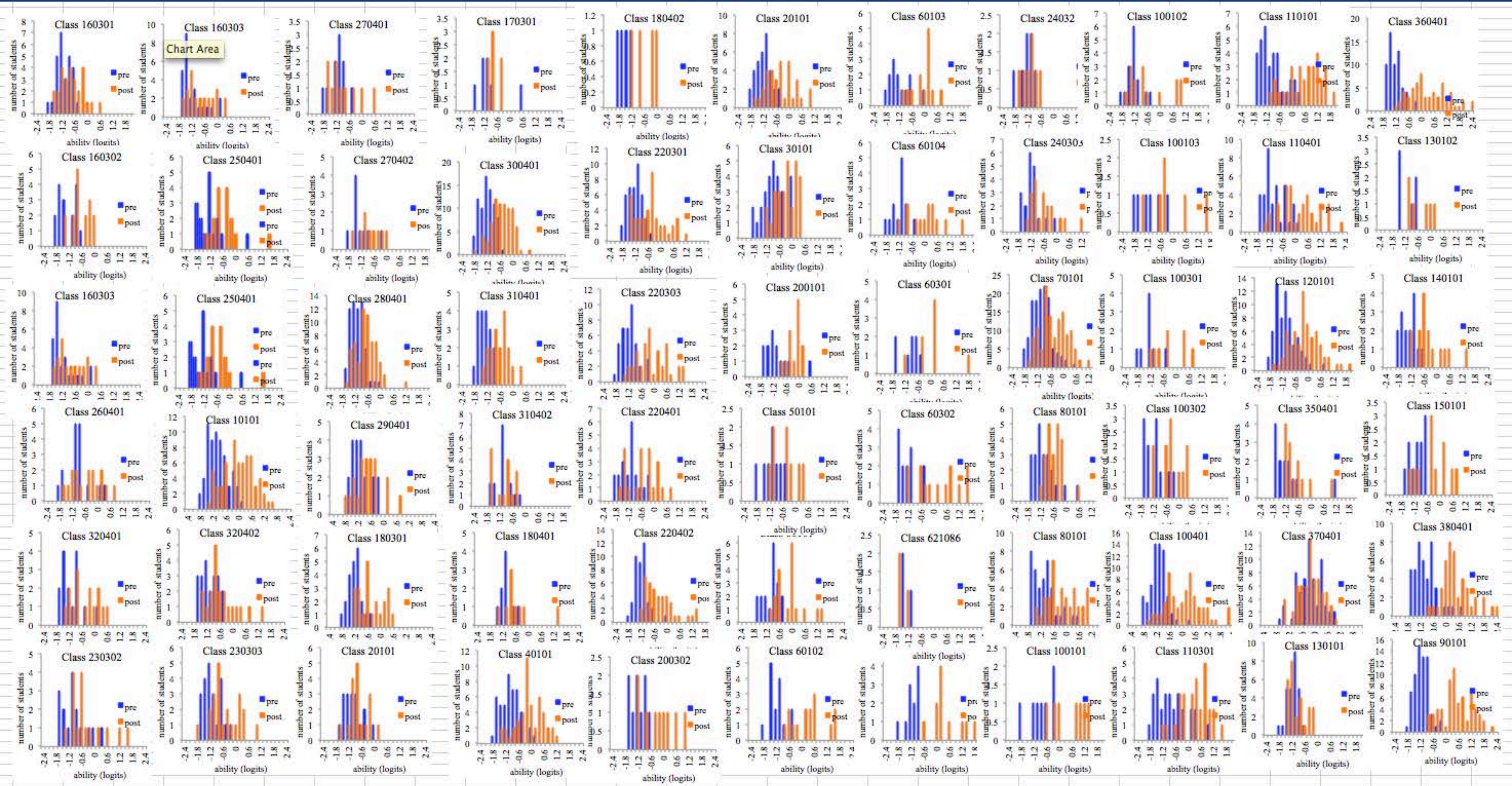


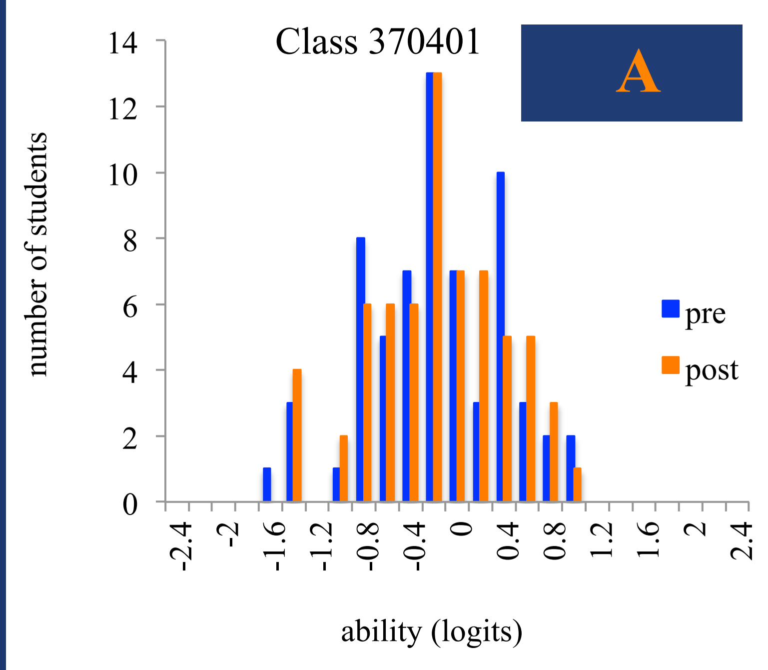
$$<g> = \frac{<\text{post\%}> - <\text{pre\%}>}{100\% - <\text{pre\%}>}$$
2-yr Colleges
4-yr Bachelors Colleges
4-yr Masters/Bach. Univ.
Research Univ.
Normalized gain <g>
LSCI Pre-test %
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0
10
20
30
40
50
60
70
80
90
100

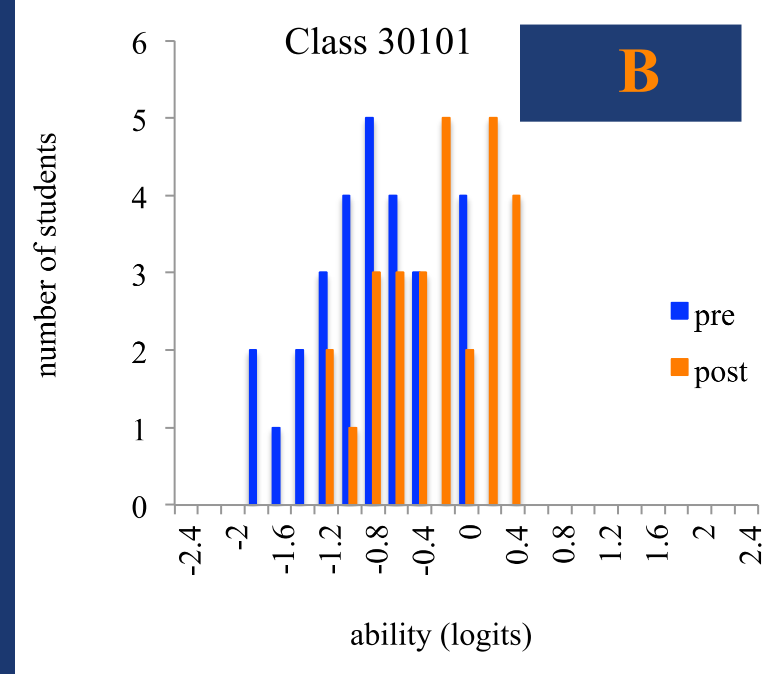
Item Response Theory (IRT)

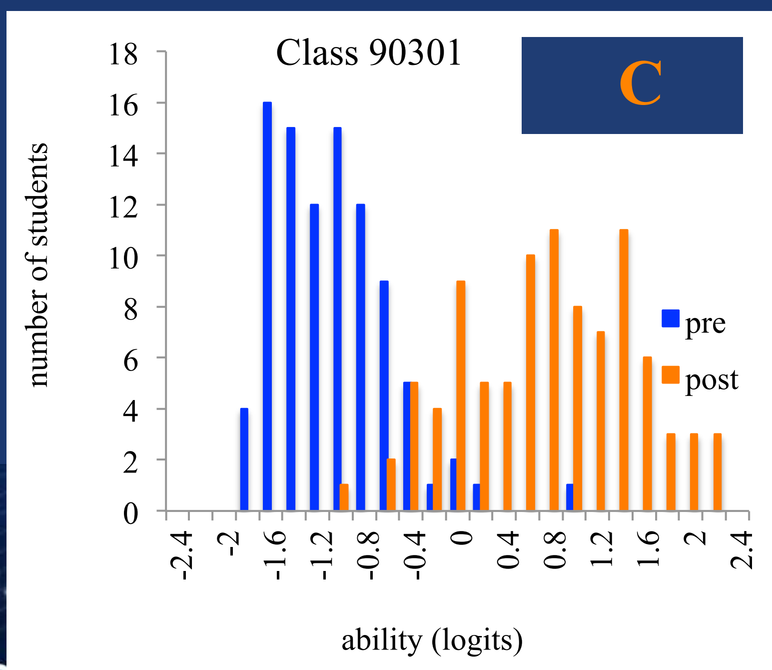
$$P(X_{pi} = 1 \mid \theta_p, b_i) = \frac{\exp[\theta_p - b_i]}{1 + \exp[\theta_p - b_i]}$$

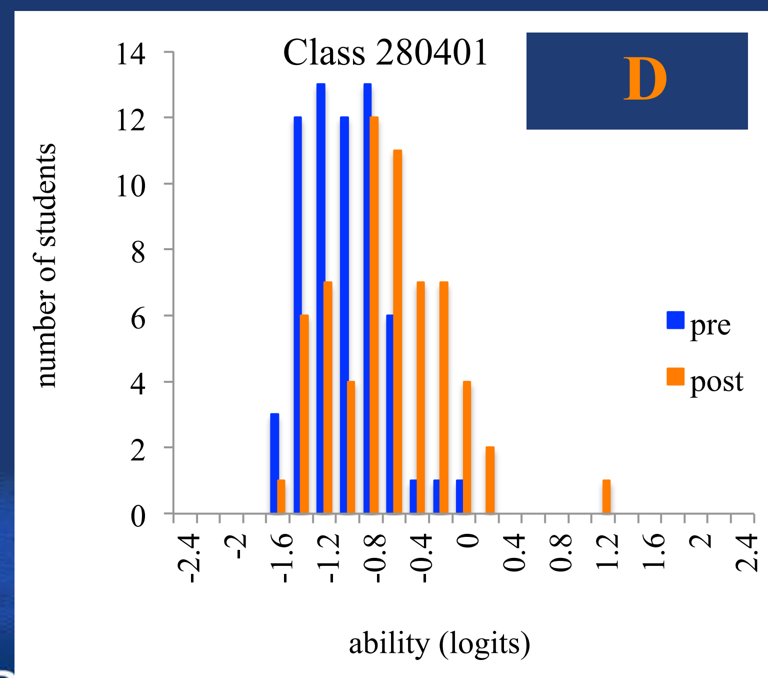

Item 1
Item 3
Item 4
Item 5
Item 6
Item 10
Item 11
Item 12
Item 13
Item 14
Item 16
Item 17
Item 20
Item 24
Item 26
Item 1819
Item 222
Item 78
Item 15
Item 9

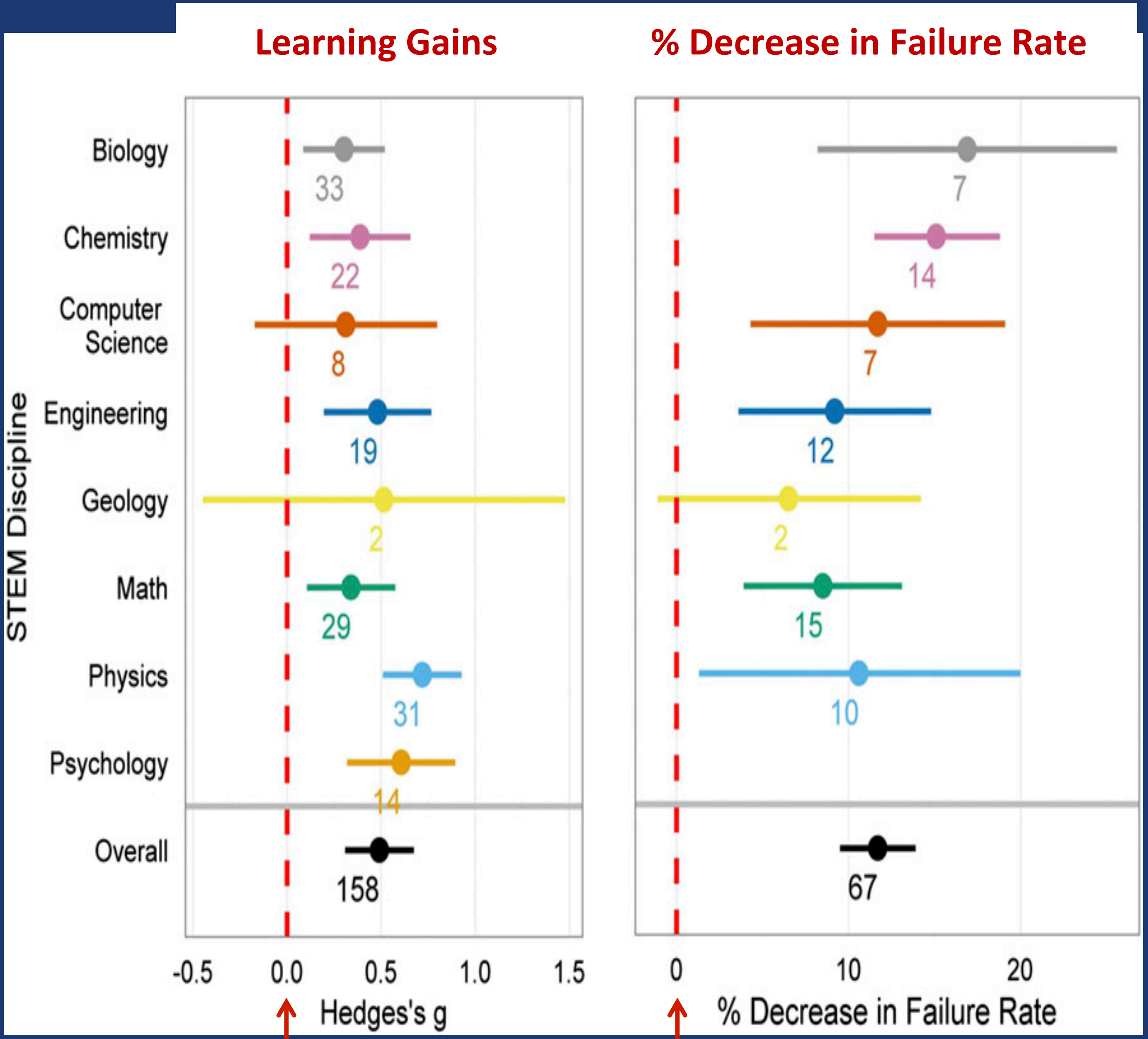

Class 160301
Class 160303
Chart Area
Class 270401
Class 170301
Class 180402
Class 20101
Class 60103
Class 24032
Class 100102
Class 110101
Class 360401
Class 160302
Class 250401
Class 270402
Class 300401
Class 220301
Class 30101
Class 60104
Class 100103
Class 110401
Class 130102
Class 160303
Class 250401
Class 280401
Class 310401
Class 220303
Class 200101
Class 60301
Class 70101
Class 100301
Class 120101
Class 140101
Class 260401
Class 10101
Class 290401
Class 310402
Class 220401
Class 50101
Class 60302
Class 80101
Class 100302
Class 350401
Class 150101
Class 320401
Class 320402
Class 180301
Class 180401
Class 220402
Class 621086
Class 80101
Class 100401
Class 370401
Class 380401
Class 230302
Class 230303
Class 20101
Class 40101
Class 200302
Class 60102
Class 100101
Class 110301
Class 130101
Class 90101
number of students
ability (logits)
pre
post


Class 370401
A
number of students
ability (logits)
pre
post


Class 30101
B
number of students
ability (logits)
pre
post


Class 90301
C
number of students
ability (logits)
pre
post


Class 280401
D
number of students
ability (logits)
pre
post



Numbers indicate # of studies reviewed

traditional lecture class - mean scores

Freeman S et al. PNAS 2014;111:8410-8415

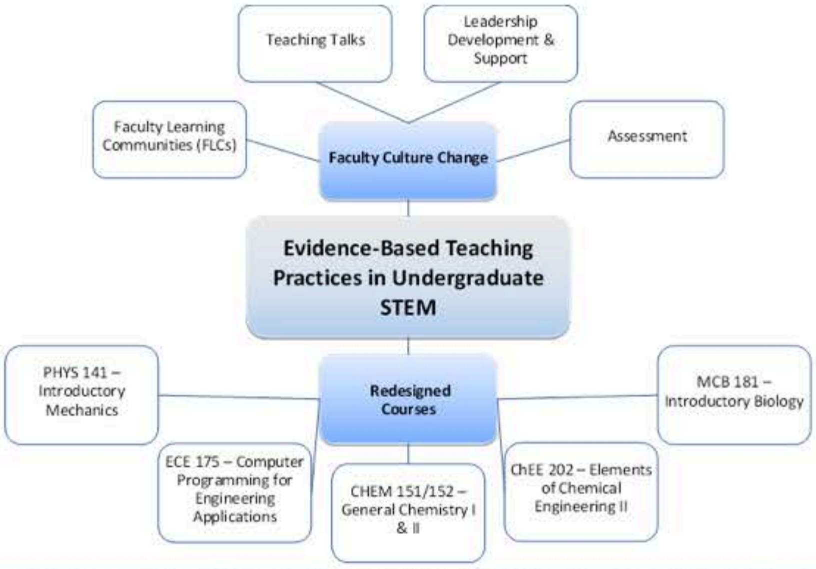
UA-AAU Undergraduate STEM Education Project

Welcome

Transforming Undergraduate STEM Education

Our Central Goals:

The UA-AAU STEM Education Project seeks to provide thousands of science and engineering majors at the University of Arizona with solid understanding in core STEM disciplines. For this purpose, we are engaged in the redesign of three foundational science courses (general chemistry, introductory biology, and introductory physics/mechanics) and two introductory engineering courses (elements of chemical engineering II and computer programming for engineering applications). The course redesigns are using student-centered and active learning pedagogy to enhance discipline knowledge and conceptual understanding. Three common themes cut across all redesign efforts: 1) promotion of information and quantitative literacy, 2) use of real-life applications in problem solving, and 3) use of models to develop conceptual understanding. The topics covered in the courses are being critically examined to emphasize core disciplinary ideas, problem-solving abilities, critical thinking, and teamwork, to ensure students are provided with a solid foundational understanding.



News

Coming Soon! STEM Teaching Award

A Call for Nominations for the **Undergraduate STEM Teaching Excellence Award** for Sping, 2015 is Coming Soon!

FLCs Spring 2015

The first meeting of the four FLC groups for Spring 2015 will take place on Wednesday, January 21st.

View More>>

staff login

Insights from the Univ. of Arizona AAU STEM reform effort in Physics

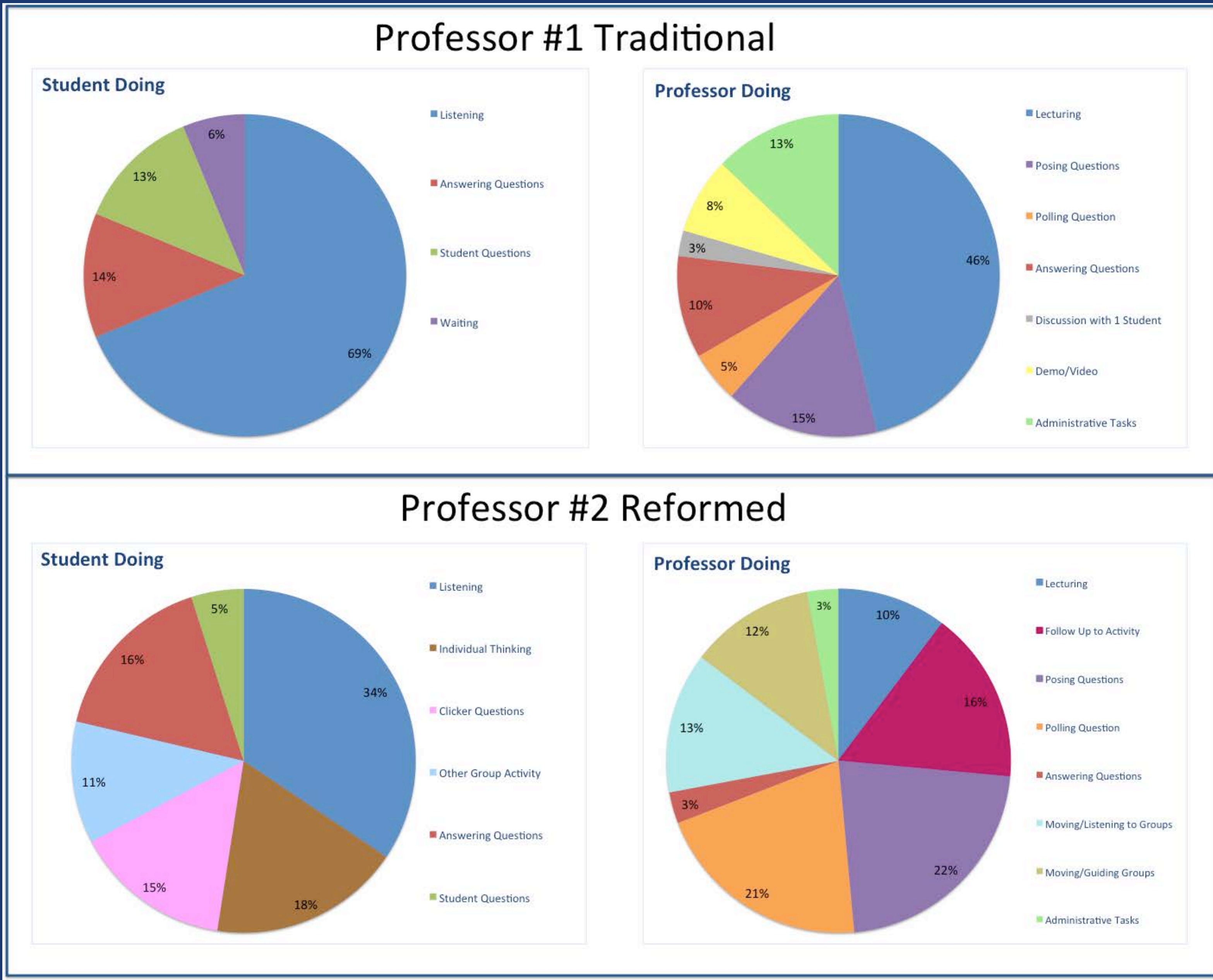
Reformed Class

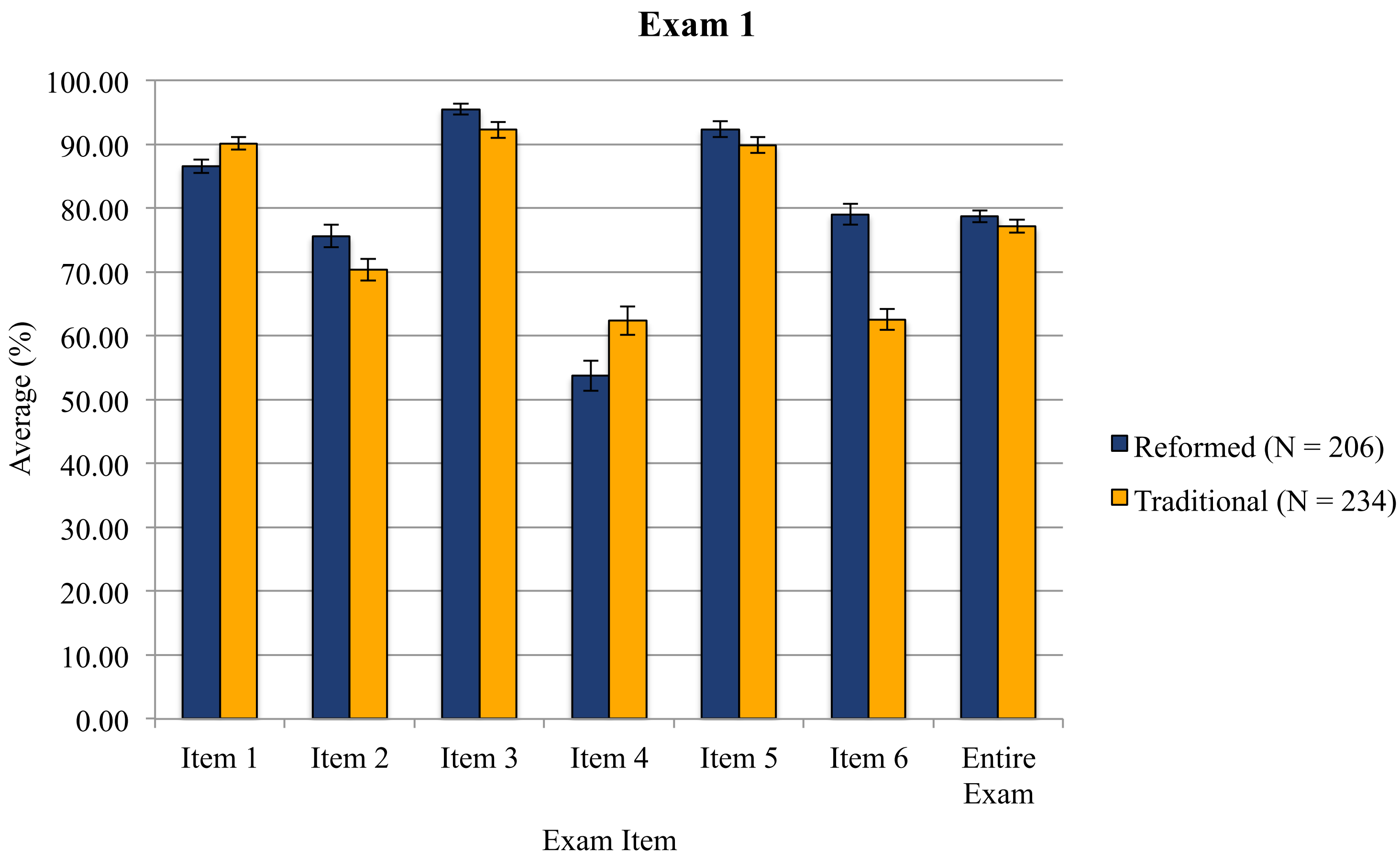
- Two 50 minute lectures per week
  - Focused on introducing concepts using active engagement instructional strategies and on collaborative group problem solving
  - Minimal derivations of equations
- Each student also attends a 50 minute recitation sections per week
  - Led by graduate TA with assistance from undergraduate peer instructors
  - Students work on collaborative tutorials, which promote reasoning abilities and problem solving skills
- Instructor experienced in astronomy and physics education research, but teaching PHYS 141 for the first time

Traditional Class

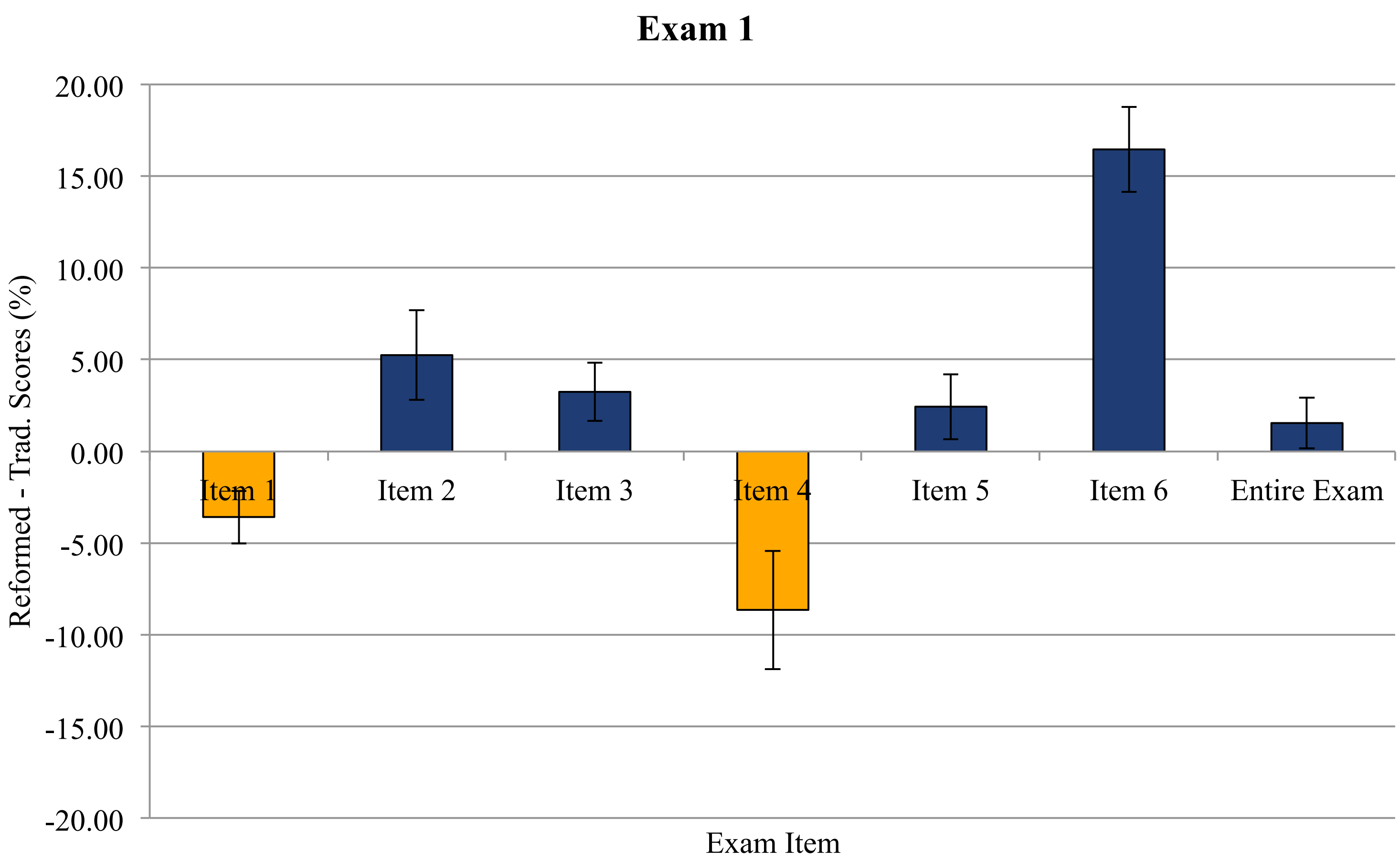
- Three 50 minute lectures per week
  - Focused on introducing concepts and on instructor-led modeling of problem solving
  - Many derivations of equations
- Instructor experienced in teaching PHYS 141 and widely regarded by faculty and students as an excellent lecturer

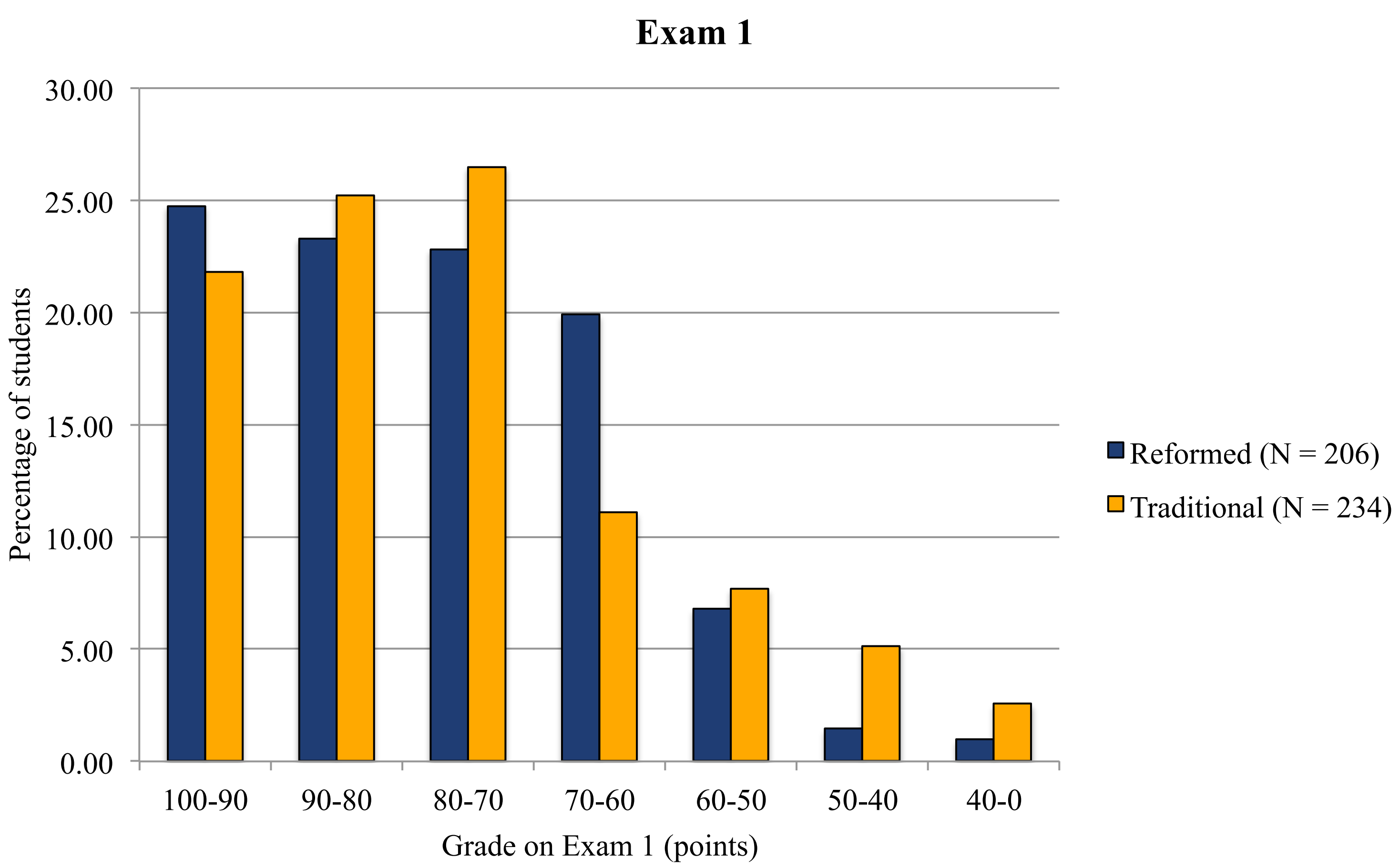
COPUS data from UA Calc-Physics Course Reforms

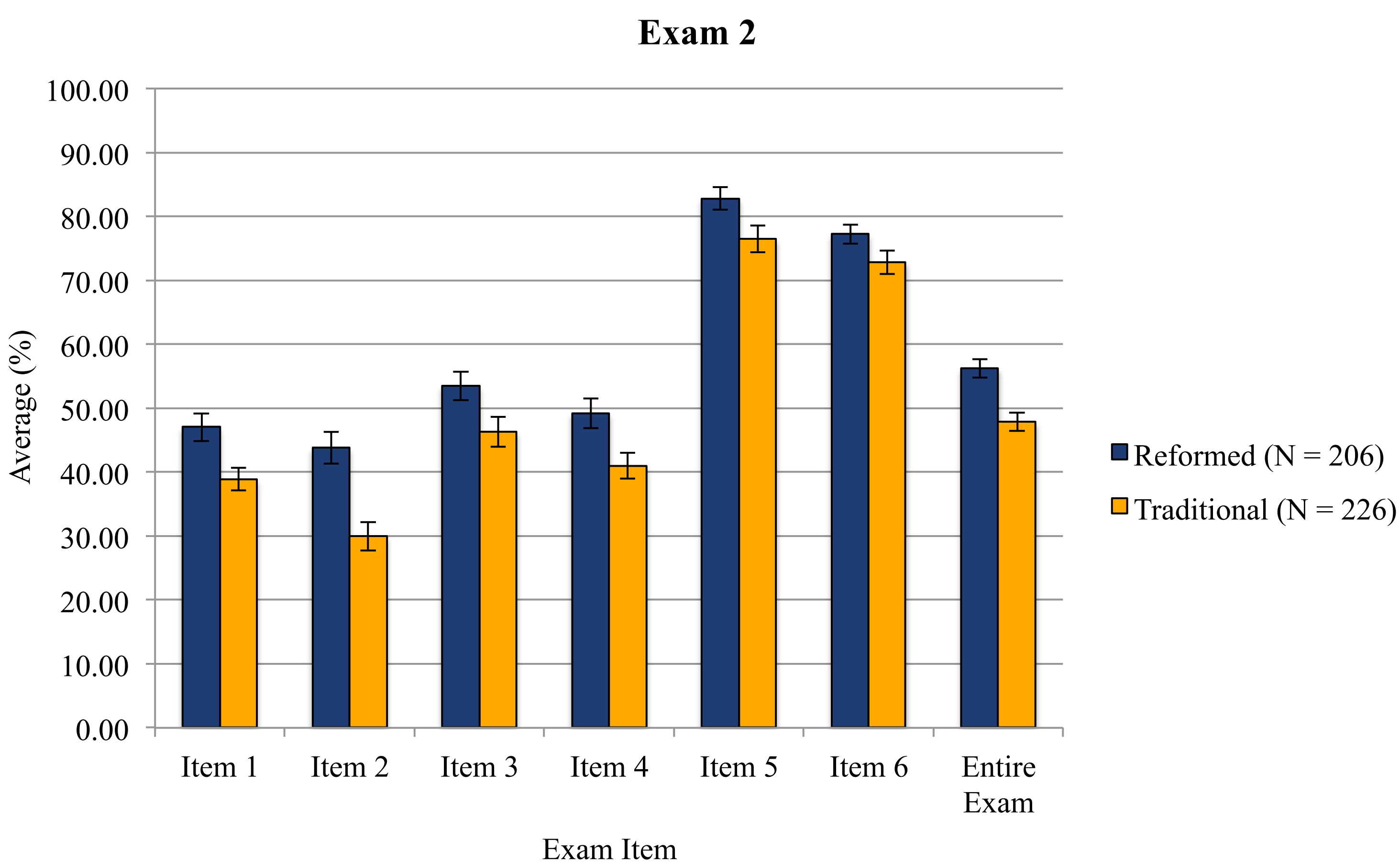


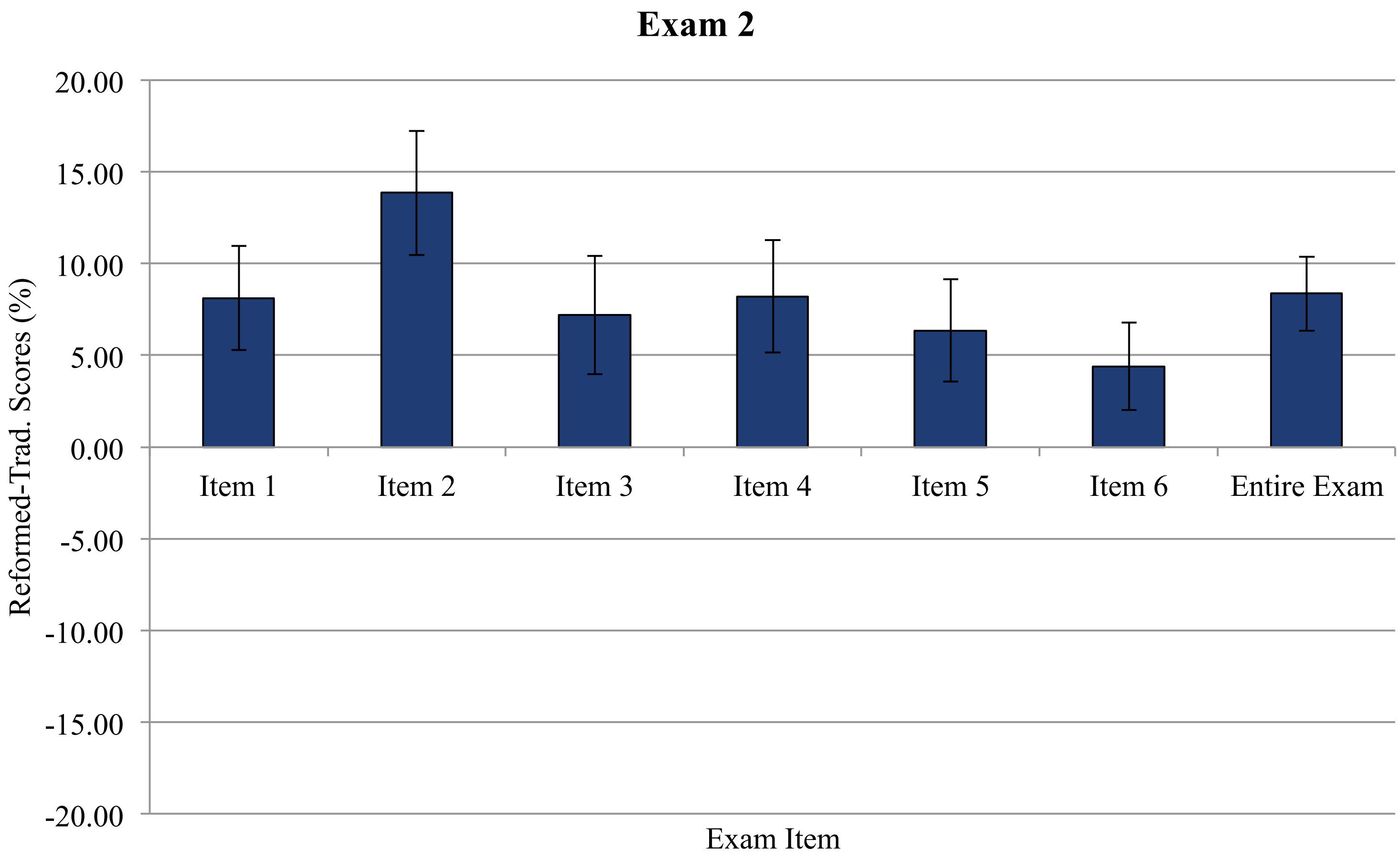


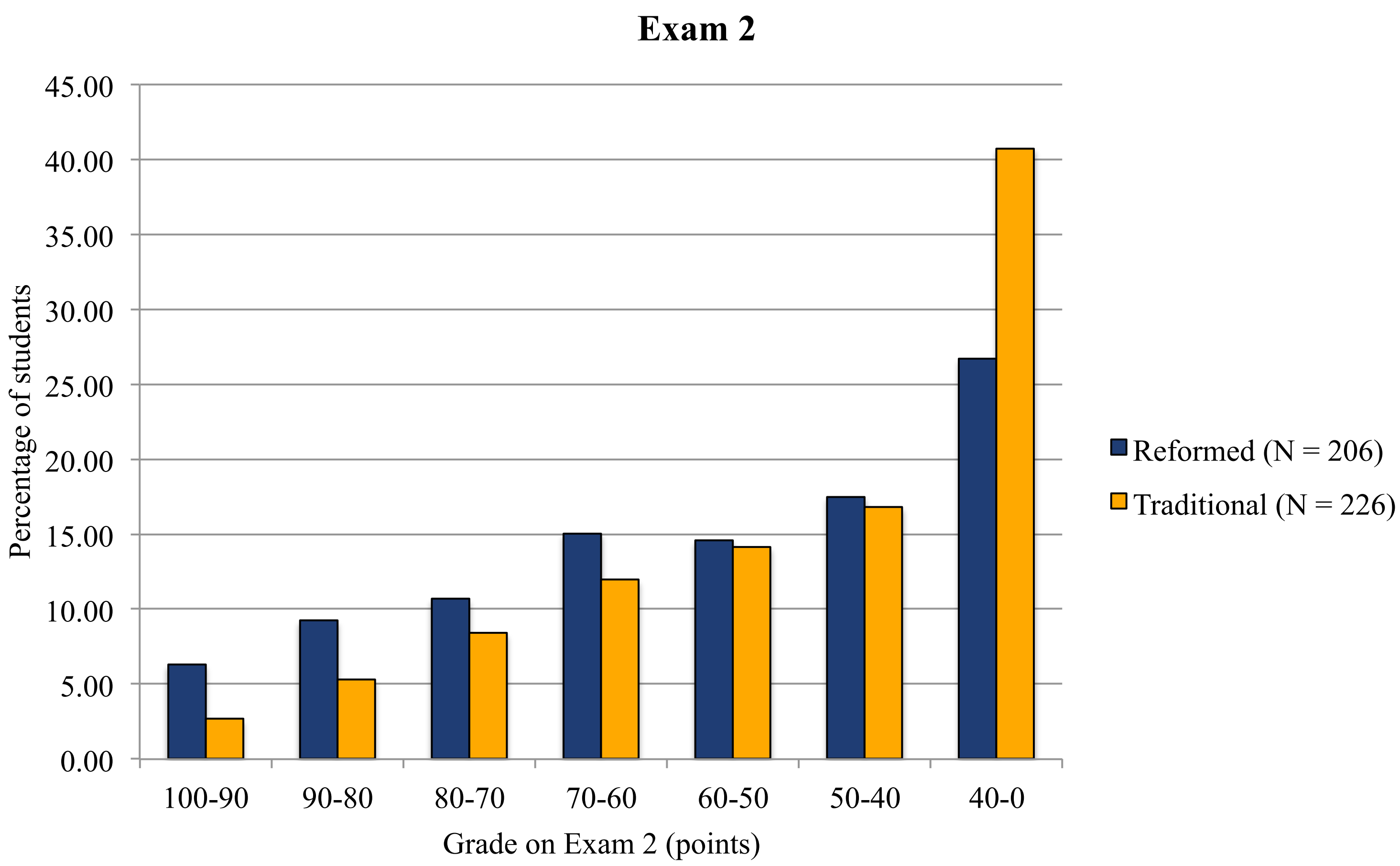
Exam 1
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Average (%)
Item 1
Item 2
Item 3
Item 4
Item 5
Item 6
Entire Exam
Exam Item
Reformed (N = 206)
Traditional (N = 234)

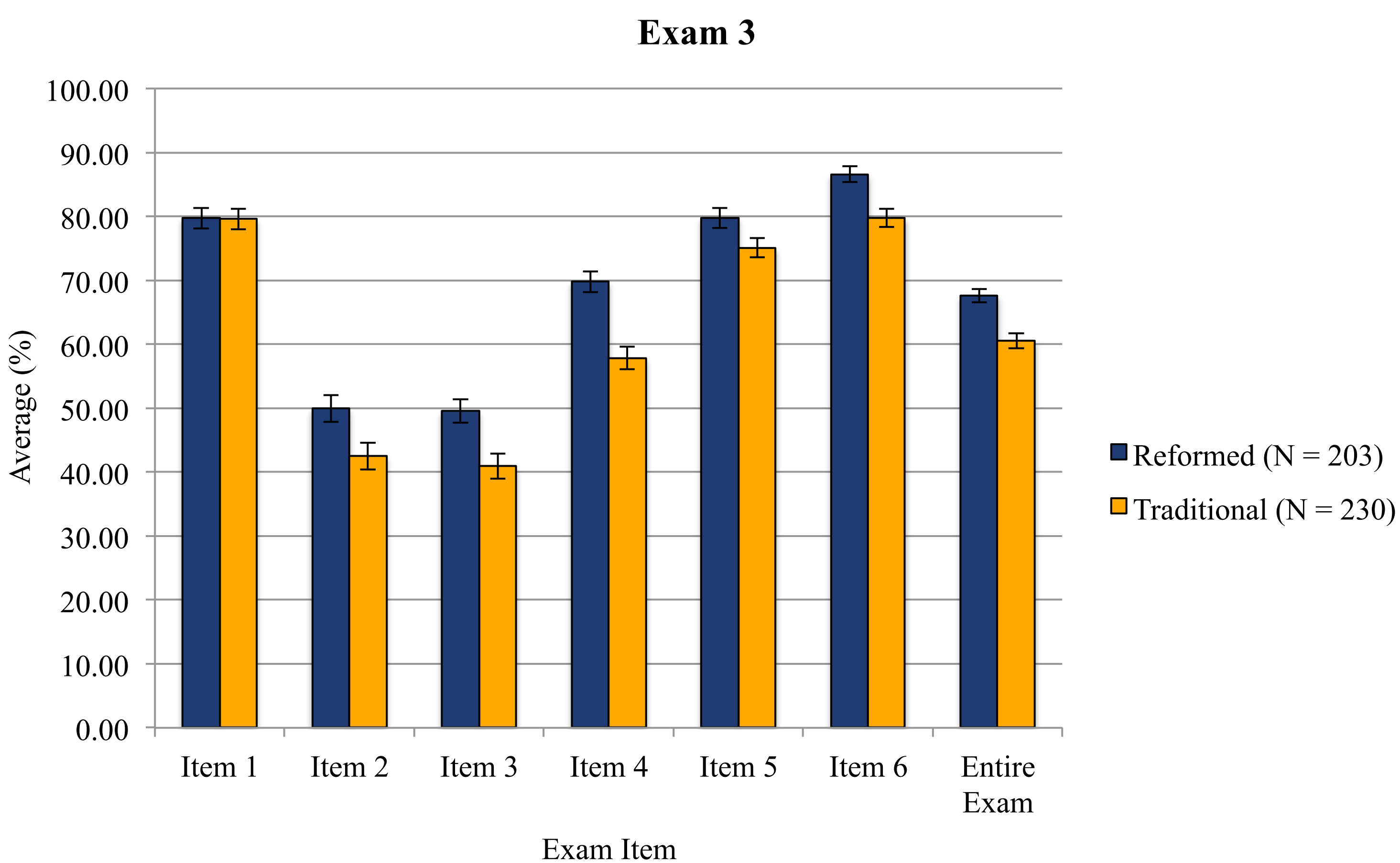

Exam 1
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
Reformed - Trad. Scores (%)
Item 1
Item 2
Item 3
Item 4
Item 5
Item 6
Entire Exam
Exam Item

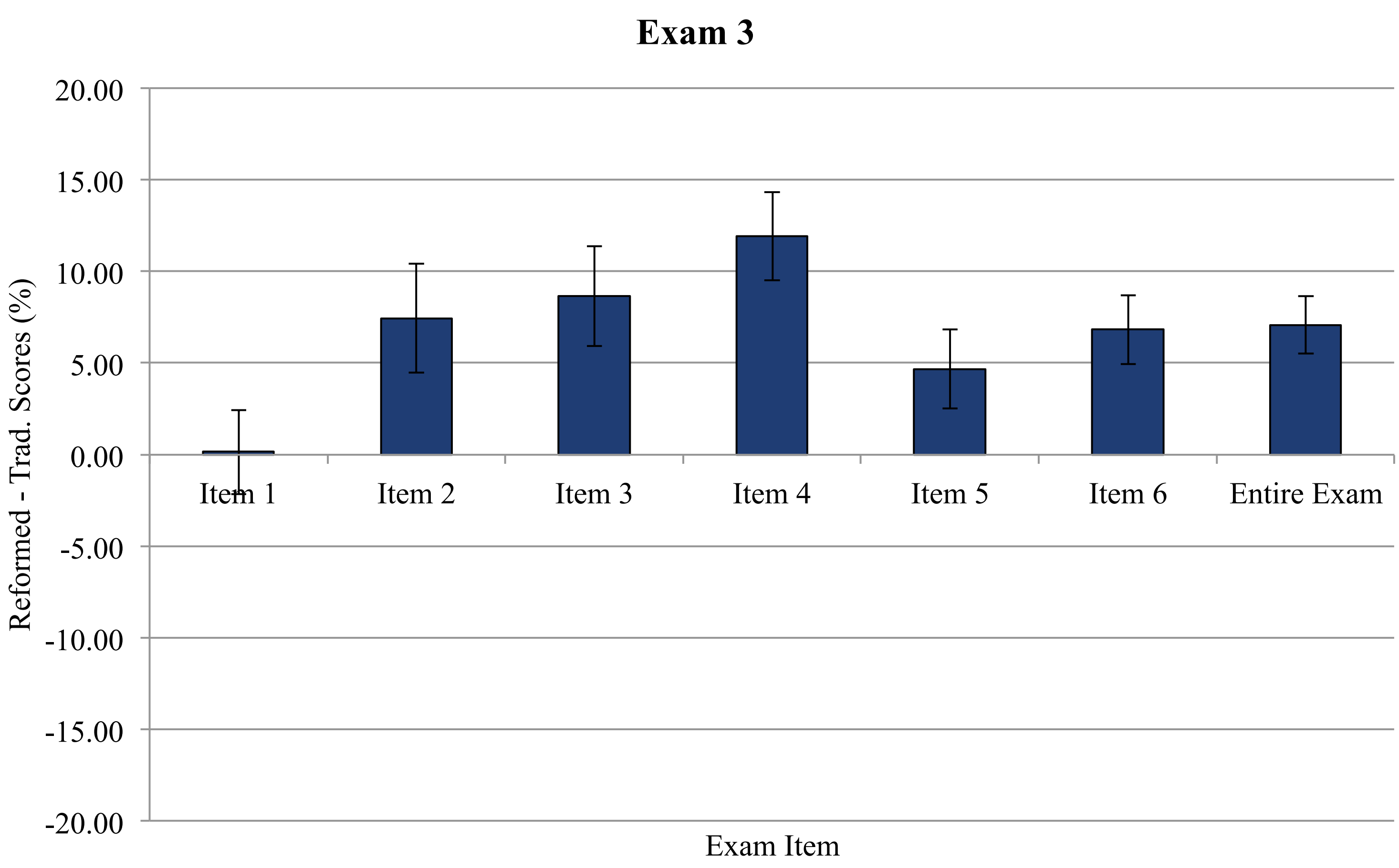

Exam 1
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Percentage of students
100-90
90-80
80-70
70-60
60-50
50-40
40-0
Grade on Exam 1 (points)
Reformed (N = 206)
Traditional (N = 234)

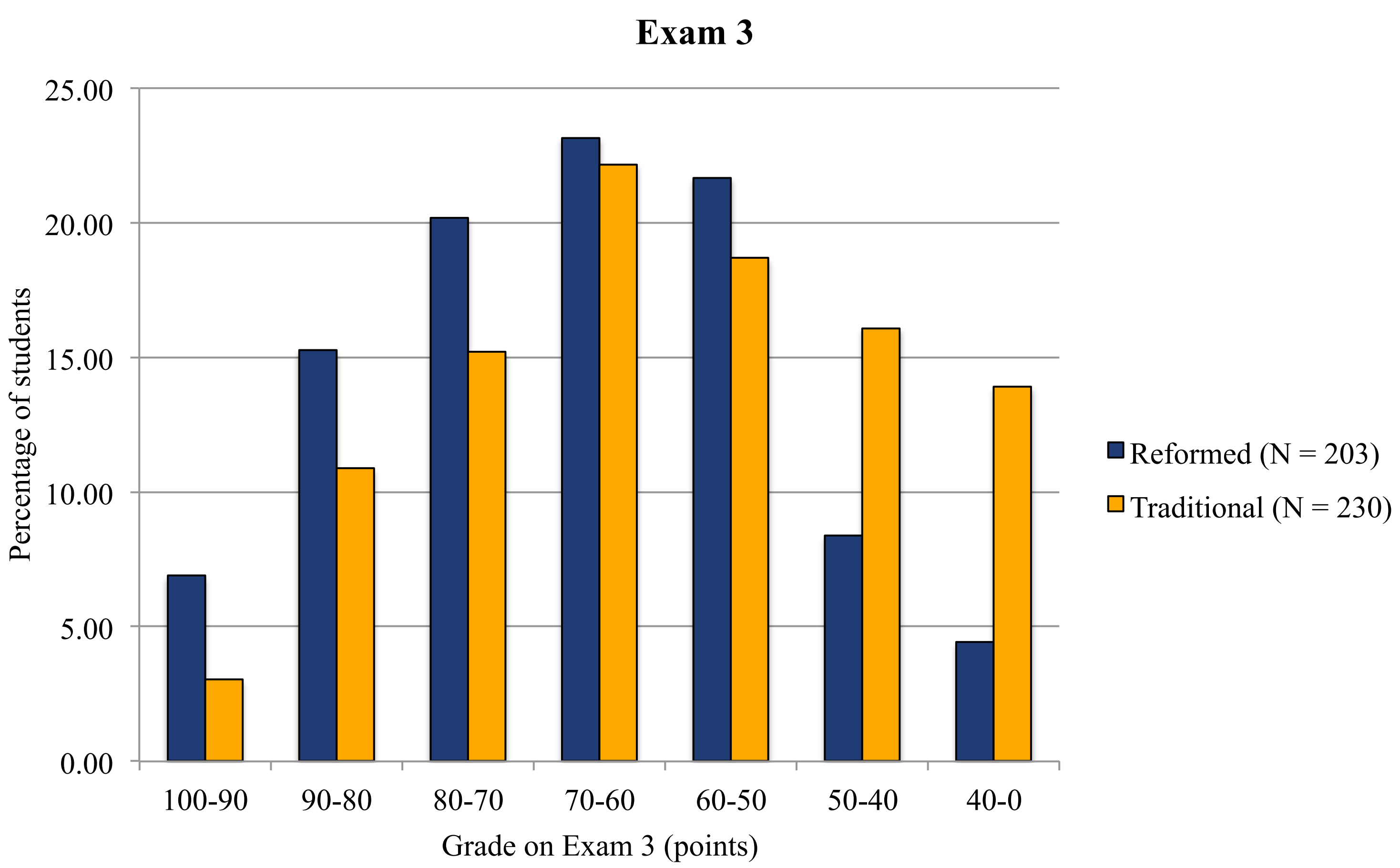

Exam 2
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Average (%)
Item 1
Item 2
Item 3
Item 4
Item 5
Item 6
Entire Exam
Exam Item
Reformed (N = 206)
Traditional (N = 226)

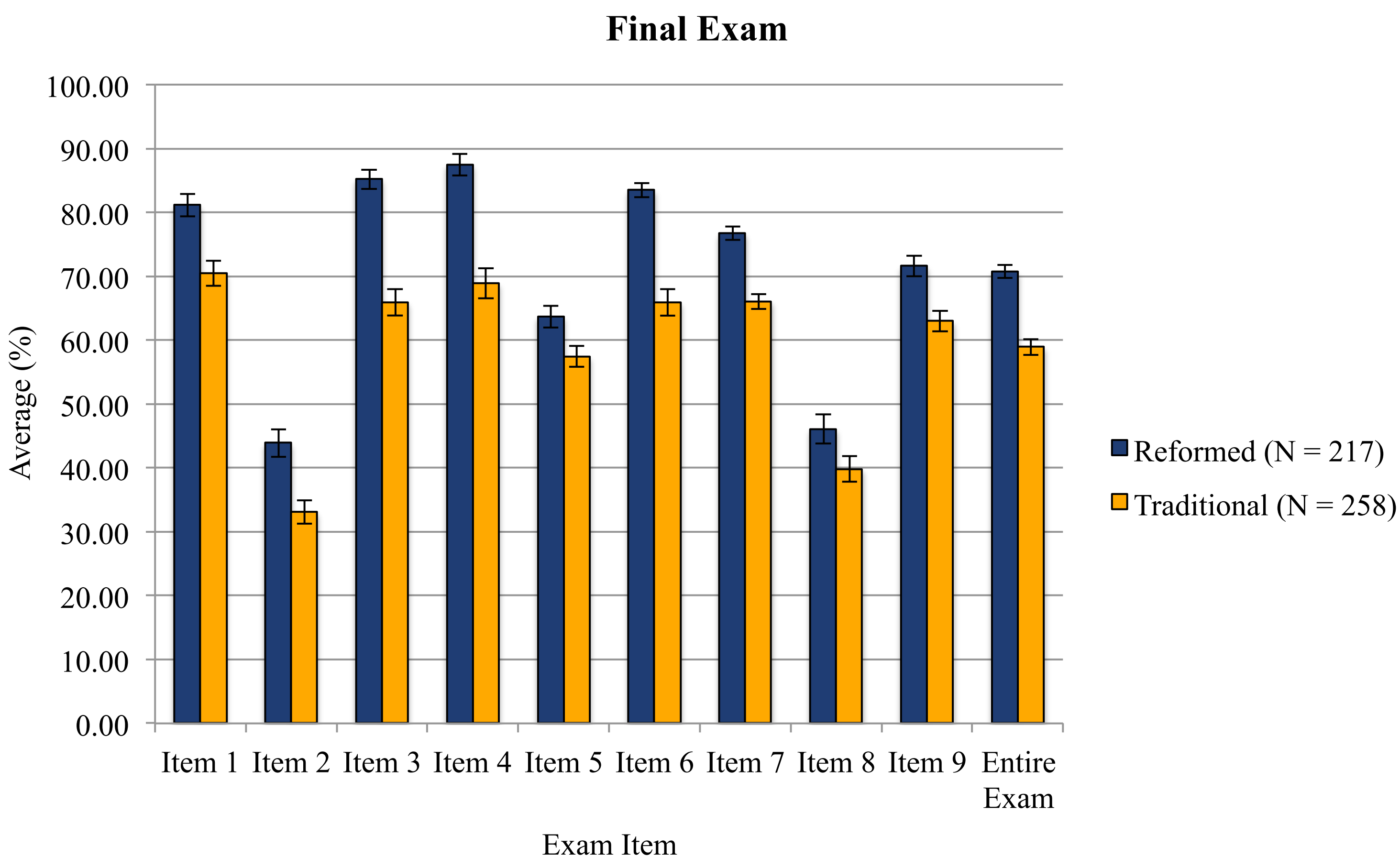

Exam 2
Reformed-Trad. Scores (%)
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
Item 1
Item 2
Item 3
Item 4
Item 5
Item 6
Entire Exam
Exam Item


Exam 2
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Percentage of students
100-90
90-80
80-70
70-60
60-50
50-40
40-0
Grade on Exam 2 (points)
Reformed (N = 206)
Traditional (N = 226)

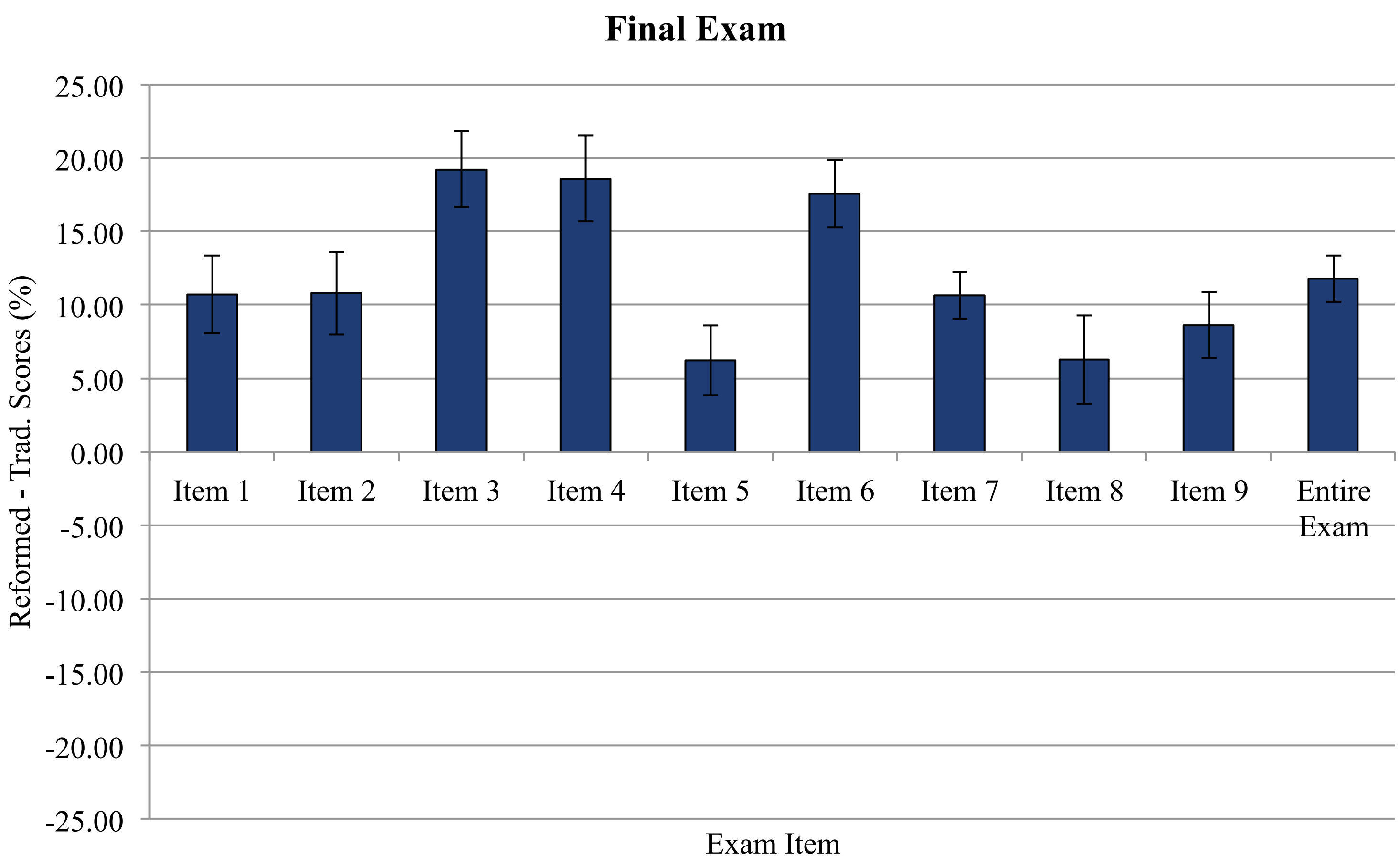

Exam 3
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Average (%)
Item 1
Item 2
Item 3
Item 4
Item 5
Item 6
Entire Exam
Exam Item
Reformed (N = 203)
Traditional (N = 230)

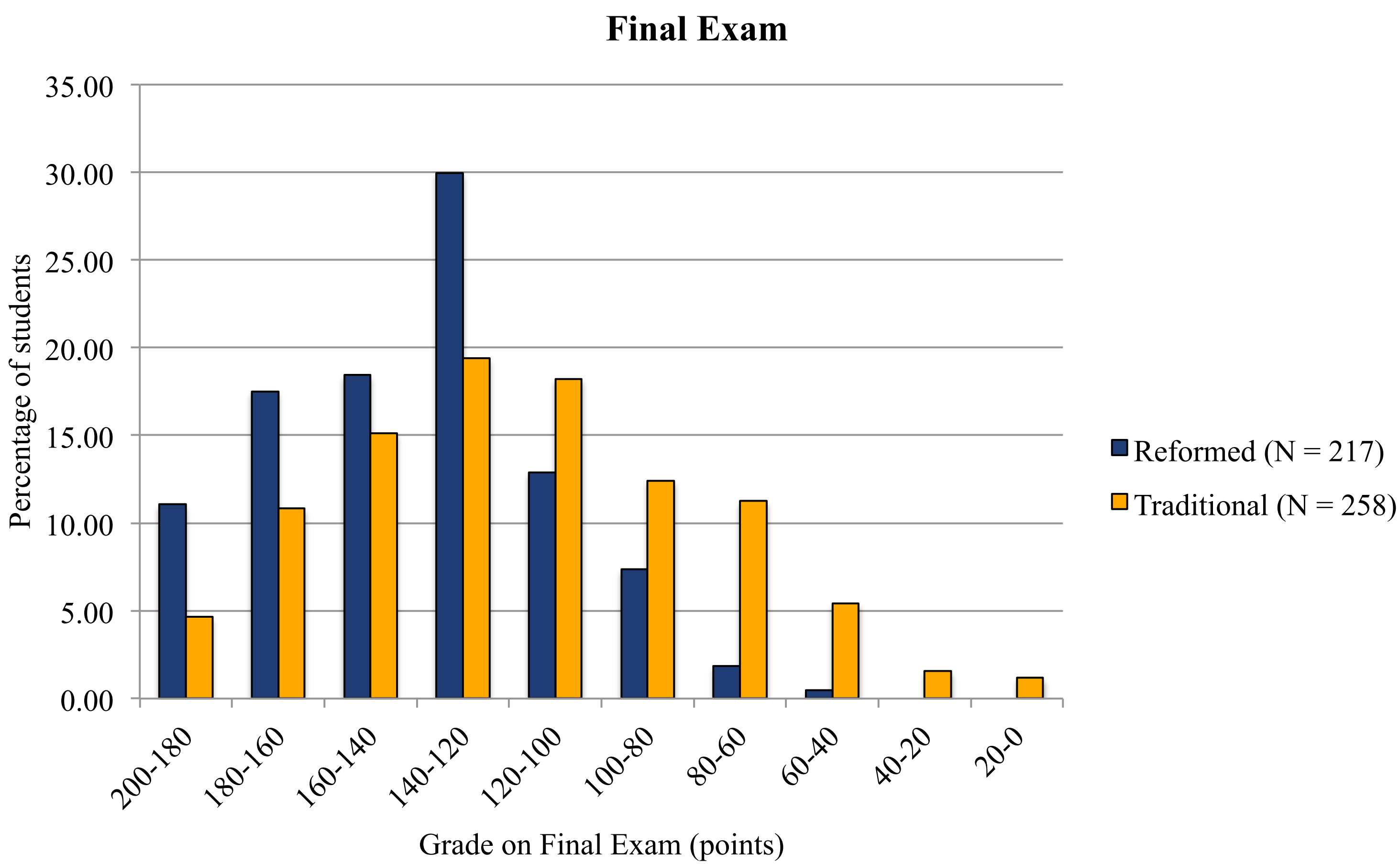

Exam 3
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
Reformed - Trad. Scores (%)
Item 1
Item 2
Item 3
Item 4
Item 5
Item 6
Entire Exam
Exam Item

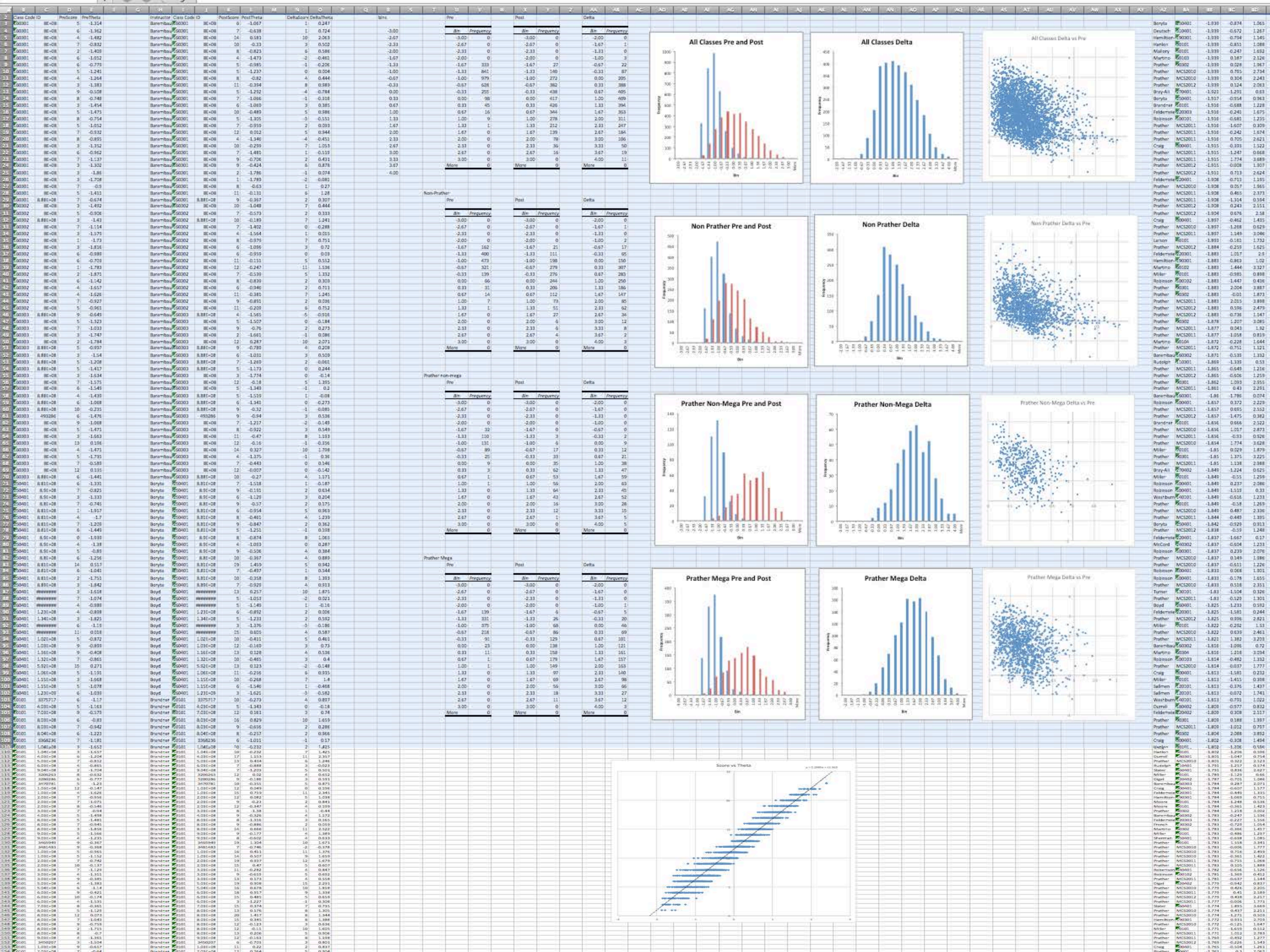

Exam 3
25.00
20.00
15.00
10.00
5.00
0.00
Percentage of students
100-90
90-80
80-70
70-60
60-50
50-40
40-0
Grade on Exam 3 (points)
Reformed (N = 203)
Traditional (N = 230)



Final Exam
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Average (%)
Item 1
Item 2
Item 3
Item 4
Item 5
Item 6
Item 7
Item 8
Item 9
Entire Exam
Exam Item
Reformed (N = 217)
Traditional (N = 258)


Final Exam
Reformed - Trad. Scores (%)
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
Item 1
Item 2
Item 3
Item 4
Item 5
Item 6
Item 7
Item 8
Item 9
Entire Exam
Exam Item


Final Exam
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Percentage of students
200-180
180-160
160-140
140-120
120-100
100-80
80-60
60-40
40-20
20-0
Grade on Final Exam (points)
Reformed (N = 217)
Traditional (N = 258)


All Classes Pre and Post
All Classes Delta
All Classes Delta vs Pre
Non Prather Pre and Post
Non Prather Delta
Non Prather Delta vs Pre
Prather Non-Mega Pre and Post
Prather Non-Mega Delta
Prather Non-Mega Delta vs Pre
Prather Mega Pre and Post
Prather Mega Delta
Prather Mega Delta vs Pre
Score vs Theta

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Workshops

Teaching Excellence Workshops

Workshops Locations
Click a location to register for a specific workshop

Fall/Winter 2012/13

1. Jamestown, North Carolina
   Regional Teaching Exchange
   Planning Meeting
   October 6, 2012
2. Long Beach, California
   Tier I,CATS
   January 5-6, 2013

Spring/Summer 2013

3. Dearborn, Michigan
   Regional Teaching Exchange
   April 20, 2013
4. Oceanside, California
   Regional Teaching Exchange
   May 4, 2013
5. Indianapolis, Indiana
   Tier I,CATS
   June 1-2, 2013
6. College Park, Maryland
   New Faculty Workshop
   June 17-20, 2013
7. Albuquerque, New Mexico
   Tier I,CATS
   August 24-25, 2013

Fall/Winter 2013/14

8. New Paltz, New York
   Regional Teaching Exchange
   September, 2013
9. Seattle, Washington
   Regional Teaching Exchange
   September or October TBD, 2013
10. Jamestown, North Carolina
    Regional Teaching Exchange
    October 4 (tentative), 2013
11. College Park, Maryland
    New Faculty Workshop
    November 7-10, 2013
12. National Harbor, Maryland
    Tier I,CATS
    January 4-5, 2014

Evaluation Time

- We care about what you have to say!
- The evaluation form is two-sided.
- Please write so we can read it.
- Pick up your certificate when you’re done.