Interactive Engagement in Large Introductory Courses

Dr. Edward Prather
University of Arizona
Center for Astronomy Education (CAE)
http://astronomy101.jpl.nasa.gov

CATS Collaboration of Astronomy Teaching Scholars
An NSF Funded Center for Astronomy Education (CAE) Program

Center for Astronomy Education
Dedicated to the professional development of introductory astronomy instructors
Interactive Engagement Strategies for ALL Classes

Dr. Edward Prather
University of Arizona
Center for Astronomy Education (CAE)
http://astronomy101.jpl.nasa.gov
How to Implementation of Active Learning and get your students’ to intellectually engage (work) during class!

Dr. Edward Prather
University of Arizona
Center for Astronomy Education (CAE)
http://astronomy101.jpl.nasa.gov
Moderation Continues to Grow by Leaps & Bounds

Tips from Our New Guest Moderator on Moderation

Hello, fellow astronomy educators! I'm Patrick M. Len ("P-dog" to my students), and I am your new Guest Moderator for Astrophler@CAE. I currently teach physics and astronomy at Cuesta College, a small community college in San Luis Obispo, CA, and have taught physics and astronomy at Cosumnes River College (Sacramento, CA), Sonoma State University (Rohnert Park, CA), and University of California (Davis, CA).

I have been closely following Astrophler@CAE for a number of years. Moving ...

More >>

>> More Teaching Strategies

CAE Methods & Materials:
A "Nebulite" Instructor's Perspective
This month's Teaching Strategy comes to us from Joe Kabbas (Harper Community College). We met Joe at our CAE Teaching Excellence Workshop in St. Louis last summer. More >>

Revisiting Think-Pair-Share:
An Expanded "How-To" Guide
After attending the Austin CAE Teaching Excellence Workshop in January, Amy Forestell, UT Austin graduate student, decided to take a look at the Think-Pair-Share... More >>

Classroom Assessment Techniques:
A Brief Overview
In our CAE Teaching Excellence Workshops, we discuss quite a few classroom assessment techniques that could be used to improve learning in an introductory... More >>

Additional Teaching Strategies >>

>> Seeing the Universe through NASA's Eyes

NASA's Image of the Day Gallery

Additional Resources >>
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 1-2, 2010
3. Seattle, WA
   Tier I/CATS
   January 8-9, 2011
4. Seattle, WA
   Tier II/CATS/Special Topics
   January 9, 2011
5. Pismo, TX
   Regional Teaching Exchange
   February 12, 2011

Spring/Summer 2011
7. New Paltz, NY
   CATS Regional Teaching Exchange
   March 26, 2011
8. El Paso, TX
   Tier I
   April 15-16, 2011
9. Seattle, WA
   CATS Regional Teaching Exchange
   April 18, 2011
10. Boston, MA
    Tier I/CATS
    May 21 & 22, 2011
11. Boston, MA
    Tier II/CATS/Special Topics
    May 22, 2011
12. Hip, HI

Fall/Winter 2011/12
13. Austin, TX
    Tier I/CATS
    January 7-8, 2012
14. Austin, TX
    Tier II/CATS/Special Topics
    January 8, 2012
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
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, application, and critical thinking.

A “metacognitive” approach to instruction can help students learn to take control of their own learning and monitor progress.

“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*
Centennial Hall Performing Arts Theater at University of Arizona
The best learners often make the worst teachers. They are, in a very real sense, perceptually challenged. They cannot imagine what it must be like to struggle to learn something that comes so naturally to them.

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 PeerInstruction
• Small Group Interactions
  – Concept Maps
  – Case Studies
  – Sorting Tasks
  – Ranking Tasks
  – Lecture-Tutorials
  – Collaborative Problem Solving
• Student Debates (individual/group)
• Whole Class Discussions
Does your class intellectually engage your students and deepen their conceptual understanding and critical thinking ability or does it reinforce the memorization of facts and declarative knowledge?

Bloom’s Taxonomy of Educational Objectives

- evaluation
- synthesis
- analysis
- application
- comprehension
- declarative knowledge

Class Response System—Medium Tech
Which of the following is the best ranking (from greatest to least), for the gravitational force exerted on asteroids 1, 2 and 3 by their partner asteroids?

A. $3 > 2 > 1$
B. $3 = 2 > 1$
C. $3 > 2 = 1$
D. $1 = 2 > 3$
E. $3 = 1 > 2$
Rank the acceleration of asteroids 1, 2 and 3 from greatest to least.

A. 1>2>3  
B. 1>3>2  
C. 3=1>2  
D. 1>2=3  
E. 2=3>1
The drawing below (not to scale) shows Star A, Star B, and Earth all in a line. Star B is 50,000 light-years from Star A, while Earth is 80,000 light-years from Star A.

When an observer on Earth can first see Star A, how old would Star A appear to an observer orbiting Star B?

a. 30,000 years old
b. 50,000 years old
c. 80,000 years old
d. 130,000 years old
What would the phase of the moon be?

A. Waxing crescent
B. Third Quarter
C. Waxing Gibbous
D. Waning Crescent
E. Waning Gibbous
A 1500 kg car is traveling north through an intersection when it is hit by a 2200 kg SUV traveling east. The two vehicles become locked together during the impact and slide together as one after the collision. The cars slide to a halt at a point 5.39 m east and 6.43 m north of the impact point. The coefficient of kinetic friction between the tires and the road is \( \mu_k = 0.75 \). How fast was each car traveling just before the impact?

If \( W_f \) is the work done by friction, then which of the following is true?

A) \( W_f = \left( \frac{1}{2} m_s v_s^2 + \frac{1}{2} m_c v_c^2 \right) - \frac{1}{2}(m_S + m_C)(v_{S+C})^2 \)

B) \( W_f = \left( \frac{1}{2} m_s v_s^2 + \frac{1}{2} m_c v_c^2 \right) - 0 \)

C) \( W_f = 0 - \frac{1}{2}(m_S + m_C)(v_{S+C})^2 \)

D) \( W_f = \left( \frac{1}{2} m_s v_s^2 + \frac{1}{2} m_c v_c^2 \right) + \frac{1}{2}(m_S + m_C)(v_{S+C})^2 - 0 \)

E) \( W_f = \left( \frac{1}{2} m_s v_s^2 + \frac{1}{2} m_c v_c^2 \right) - \frac{1}{2}(m_S + m_C)(v_{S+C})^2 - 0 \)
Pedagogical content knowledge (PCK)

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

How many of these are in ..
Rank the different methods for finding extrasolar planets from most successful to least.
We view the orbit of this planet and star at an angle, so part of the star’s motion is toward us on one side of the orbit, creating a blueshift.

...and part of the star’s motion is away from us on the other side, creating a redshift.
Amount of Doppler shift in Star’s light \[ \approx \frac{M_p}{\sqrt{(M_s \times d)}} \]
Given the location marked on the star's radial velocity curve, at which location in the planet's orbit would you expect the planet to be?
Star’s Radial Velocity Curve
Amount of Doppler shift in Star’s light $\approx \frac{M_p}{\sqrt{(M_s \times d)}}$
Amount of Doppler shift in Star’s light

\[ \approx \frac{M_p}{\sqrt{M_s \times d}} \]
Amount of Doppler shift in Star’s light

\[ \approx \frac{M_p}{\sqrt{(M_s \times d)}} \]