a place of mind

THE UNIVERSITY OF BRITISH COLUMBIA

TEACHING AND LEARNING ENHANCEMENT FUND

21st Century Framework for Science Teacher Education: Using modern technologies to affect science education

Dr. Marina Milner-Bolotin

The University of British Columbia, Vancouver, Canada

STEM 2012 Beijing, China

STEM 2014
The University of British Columbia, Vancouver, Canada
July 12-15, 2014

STEM

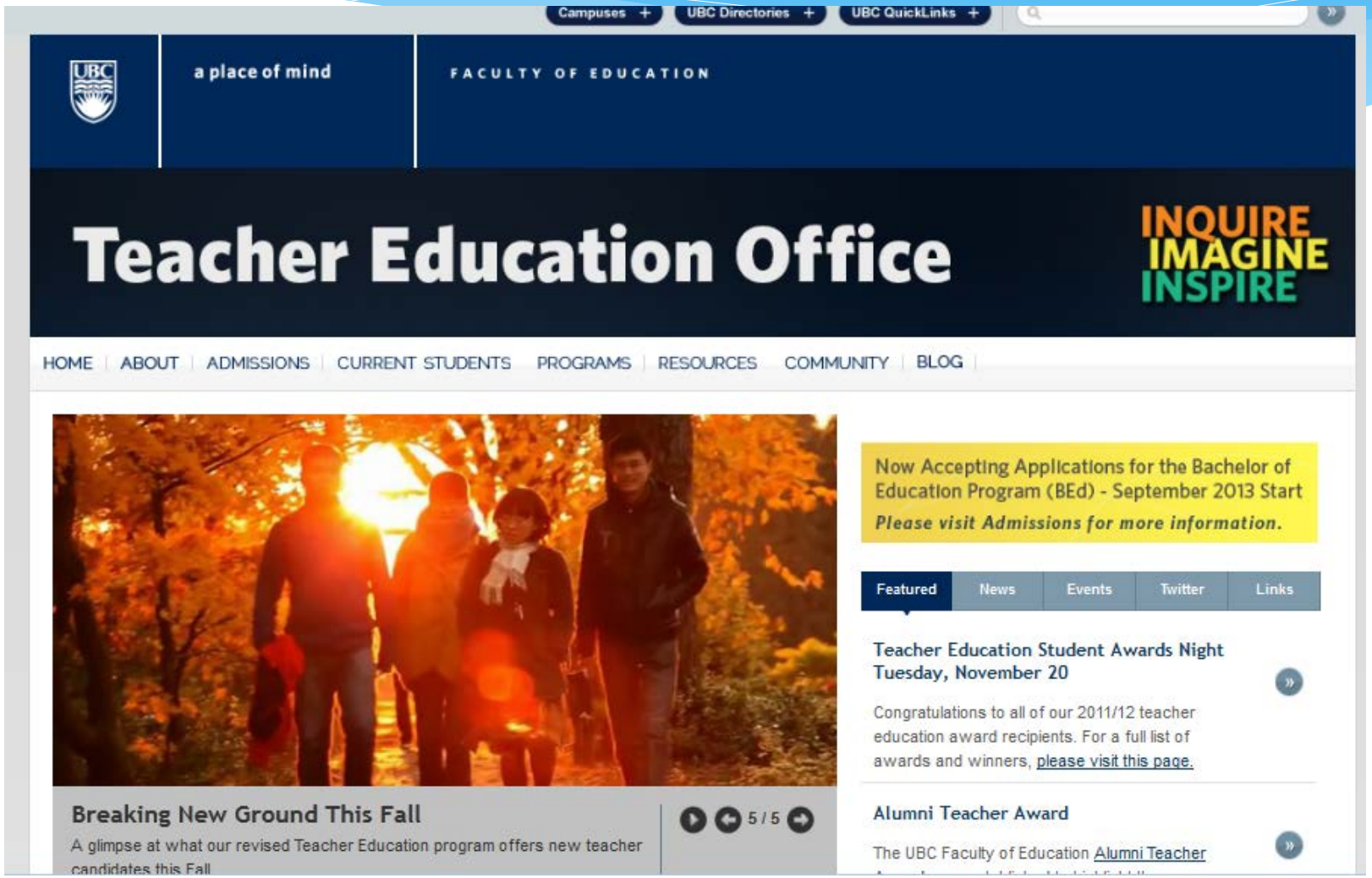
2014 | Science | Technology | Engineering | Mathematics | in Education Conference

Research Team

http://scienceres-edcp-educ.sites.olt.ubc.ca/

* Dr. Marina Milner-Bolotin (PI, science education)
* Dr. Cynthia Nicol (collaborator, mathematics education)
* Heather Fisher and Alex McDonald (EDCP Grad Students)
* Jeremy Ko and Kevin Yin (Faculty of Science undergrads)
* Teacher-Candidates in 2012 EDCP 357 (Physics Methods)
* Local Physics Teachers (testers, contributors of ideas)

UBC Teacher Education
http://teach.educ.ubc.ca/



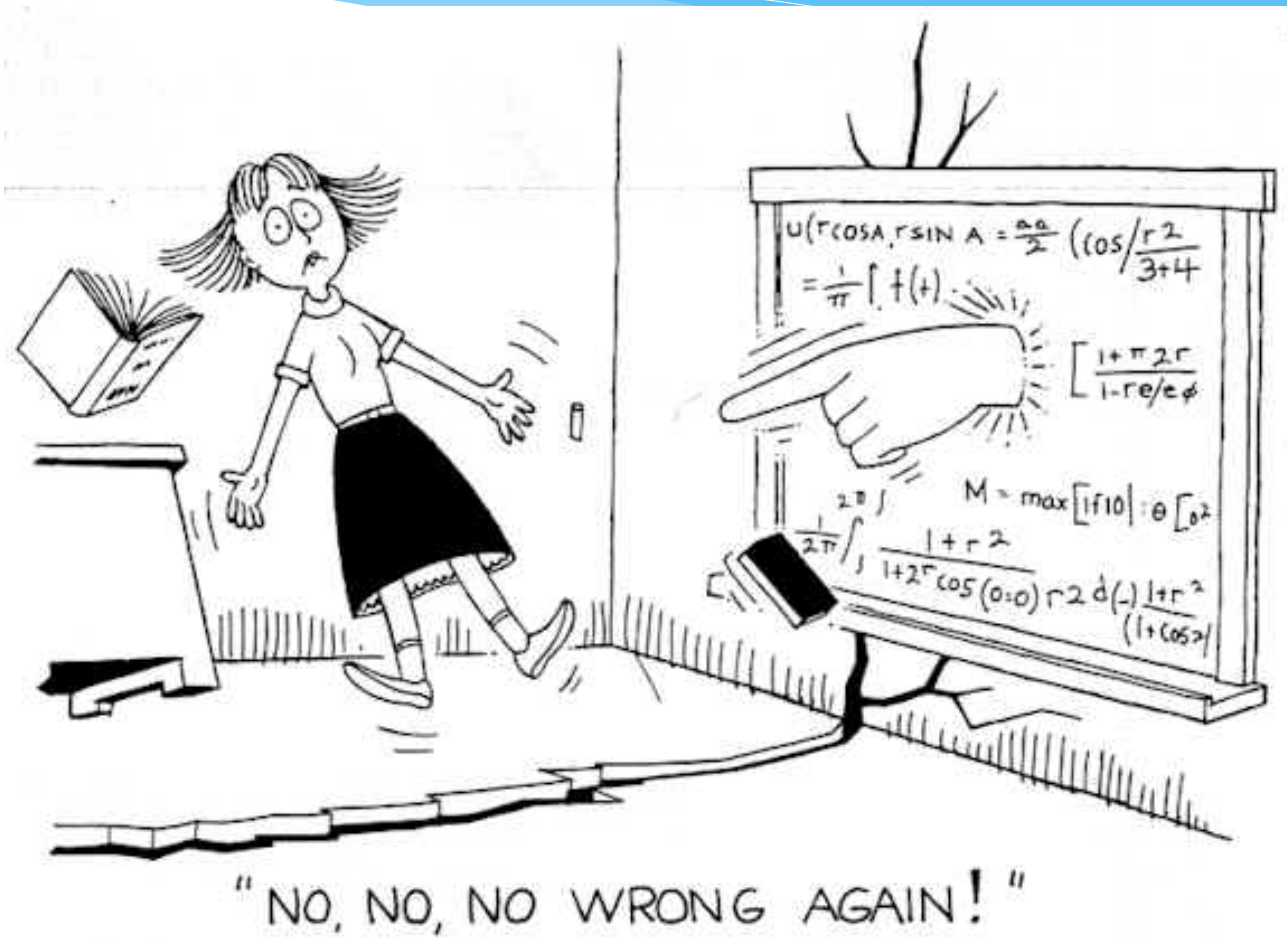
Physics Methods Course
Part of B.Ed. Program

* Enrolled: 14 teacher-candidates
* From 22-32 years old
* All of them have at least a B.Sc. in Physics
* Meet for 3 hours a week for 13 weeks
* Have various but limited teaching experiences
* Very motivated and interested in physics education

Inquiry in STEM Education

1. How do you define inquiry in the STEM context?
2. How do you engage future teachers in inquiry-based STEM education?

What Was Your STEM Experience as a Student?



WORKSHOP'S AIM

TO THINK ABOUT WHAT CAN BE DONE TO IMPROVE

MATHEMATICS AND SCIENCE K-12 TEACHER

EDUCATION THROUGH INNOVATIVE USE OF

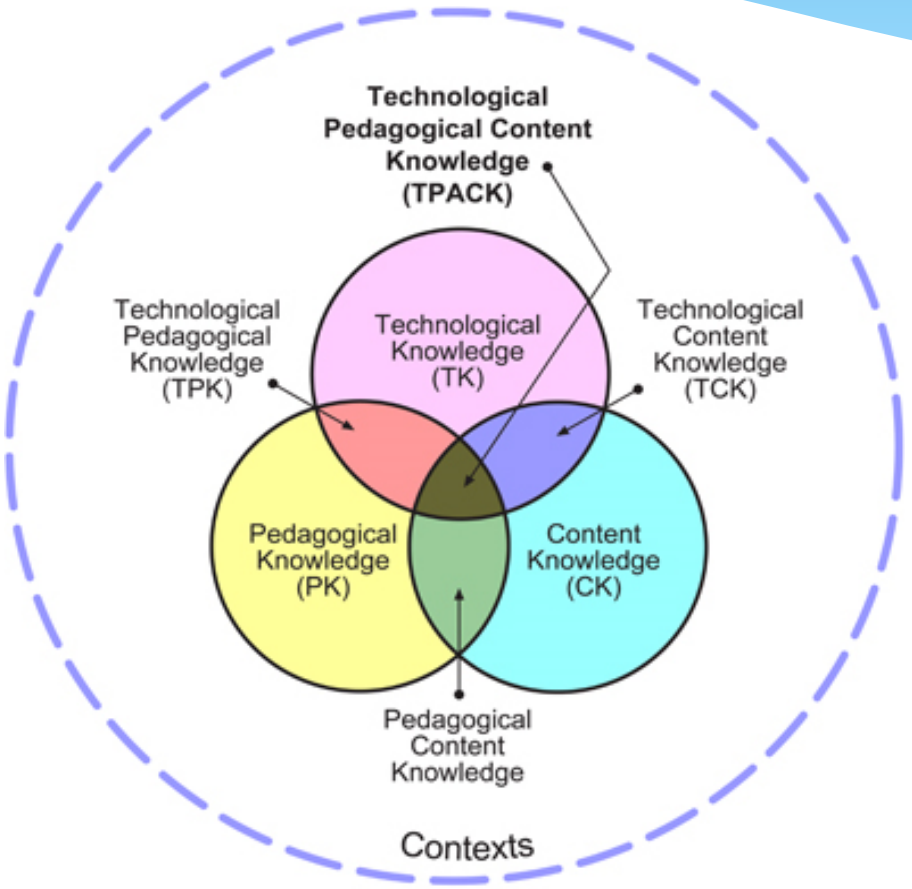
EDUCTATIONAL TECHNOLOGIES…

Technology as Means to an End…

Educational technology in STEM teacher education has a potential to help future teachers to:

1. **Acquire pedagogical-content knowledge**
2. **Generate creative approaches to teaching**
3. **Get ready to teach in the 21st century**

Technology in Teacher Education

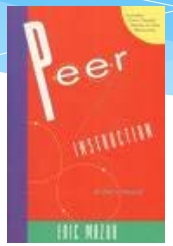


Future teachers should experience SMET technology-enhanced learning as students and as teachers

[Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? ***Contemporary Issues in Technology and Teacher Education, 9(1), 60-70.]***

Three Examples of Technologies in SMET

1. Electronic Response Systems **(clickers)**



2. Live Data Collection and Analysis **(Logger Pro)**

3. Computer Simulations **(PhET)**

I. Electronic Response Systems

Electronic response systems (clickers) in K-12 classrooms…

Research-Informed Teacher Education

2004, The Physics Teacher, 42(8), 47-48.

Tips for Using a Peer Response System in a Large Introductory Physics Class

Marina Milner-Bolotin, Physics and Astronomy Department, Rutgers, The State University of New Jersey
Piscataway, NJ 08854-8019; milnerm@physics.rutgers.edu

Teach
phy
lenge for

Clickers beyond the First Year Science Classroom

Marina Milner-Bolotin

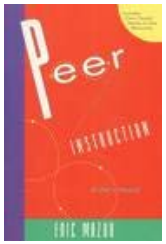
Tetyana Antimirova

Anna Petrov

2010, Journal of College Science Teaching, 40(2), 18-22.

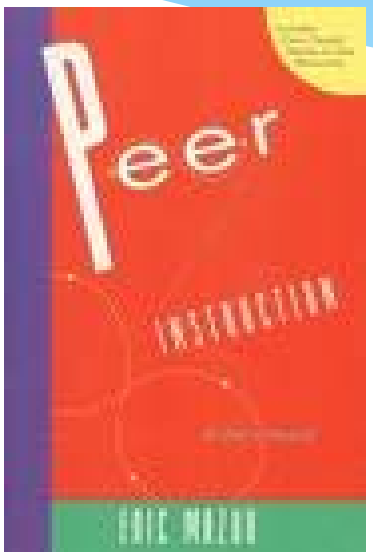
Abstract:

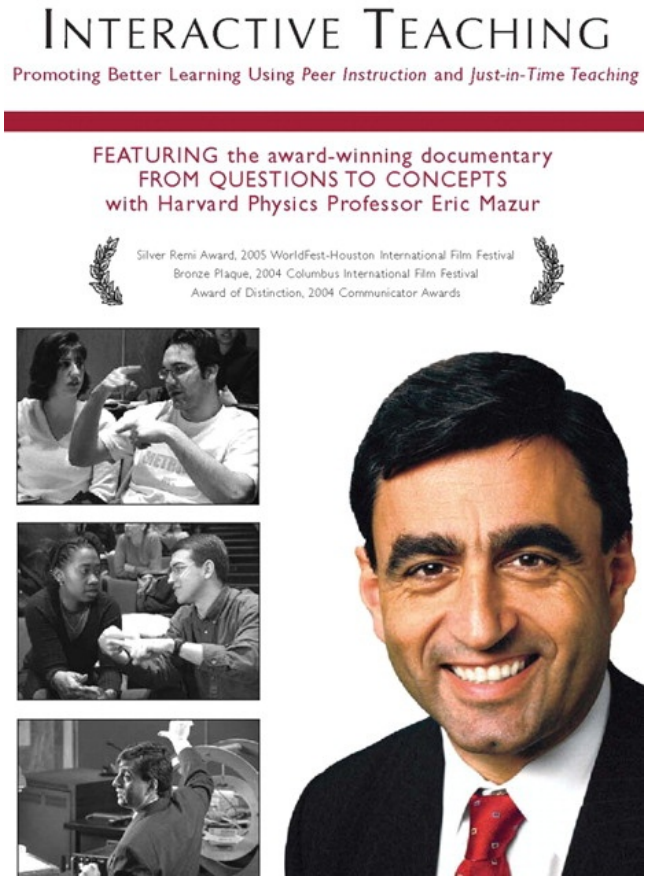
This case study's primary objective is to describe the implementation of the electronic-response-system (clickers) in a small (N=25) second

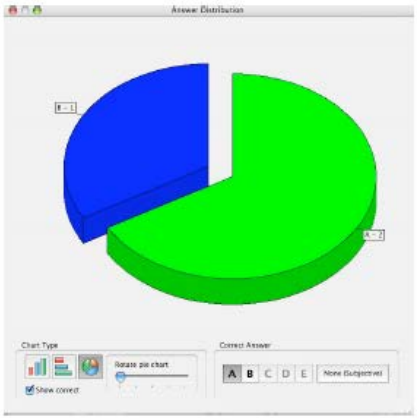


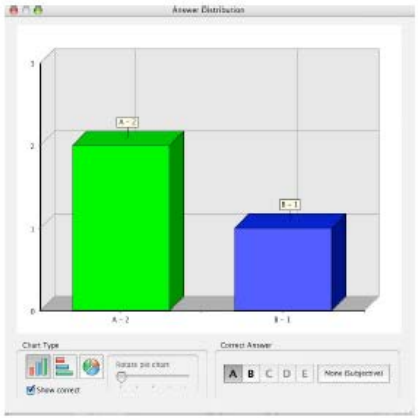
Have You Ever Heard of Peer Instruction (PI) & Eric Mazur?

A. Yes
B. No







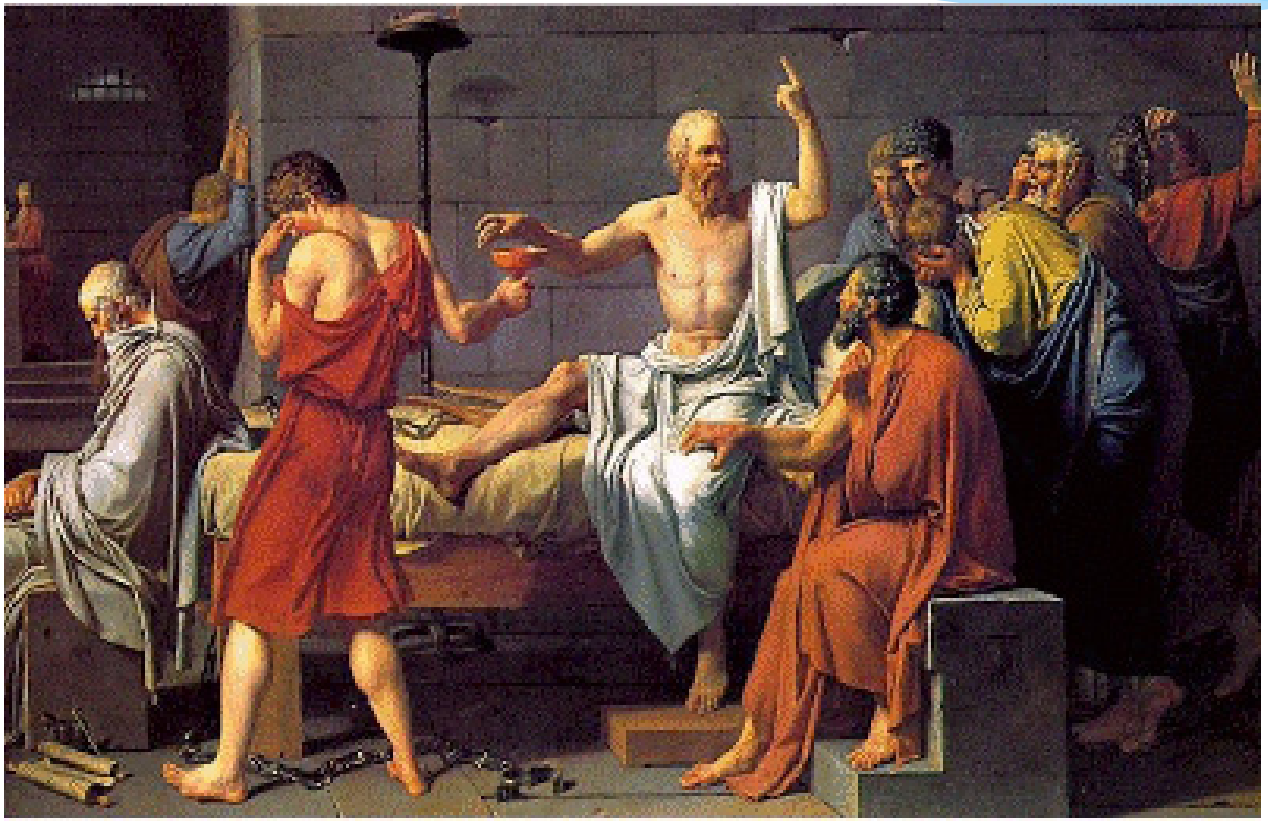


http://physics.bnu.edu.cn/copi/module/en/index.php

A Key to Clicker-Pedagogy…

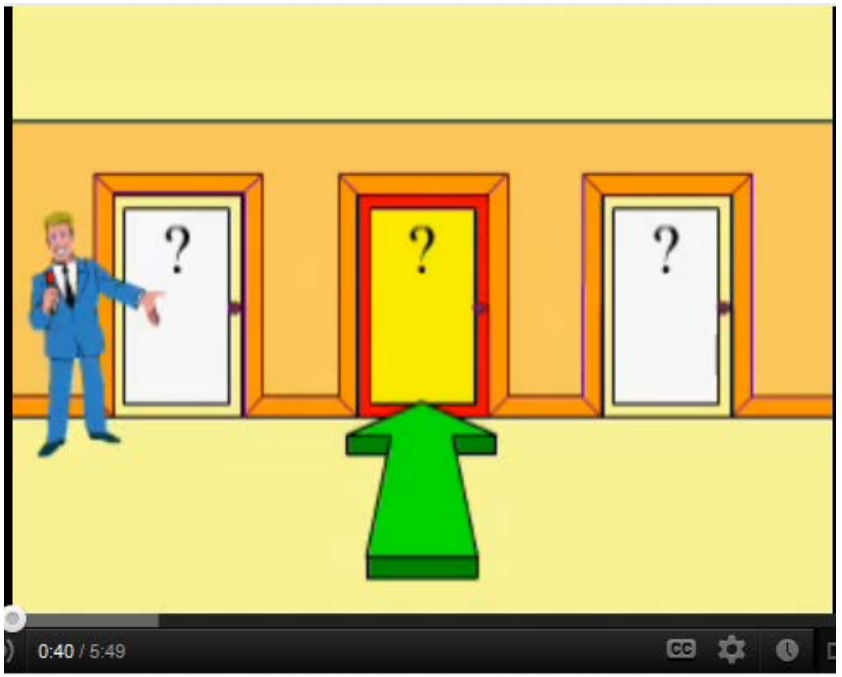
Effective use of clicker pedagogy is based on using pedagogically effective questions… The technology itself will change, yet the ability to come up with pedagogically sound questions will remain with future teachers forever!

Socrates Didn't Use Technology, Yet He Knew How to Ask Questions



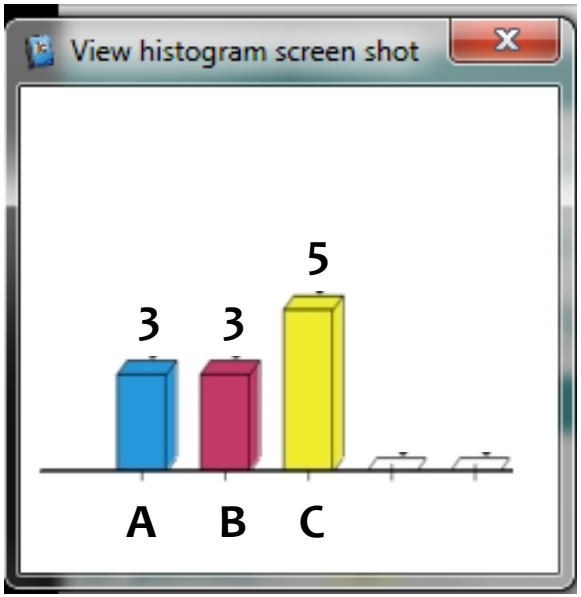
Q1: The Monty Hall Problem: Let Us Make a Deal

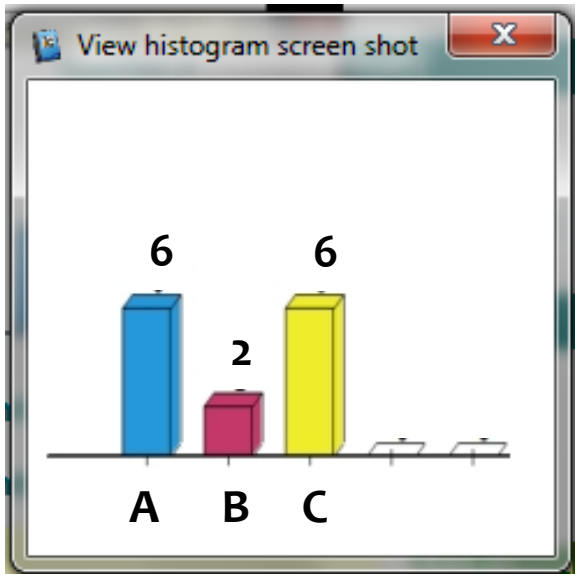
A. Stick with the original choice
B. Swap doors
C. It doesn't matter

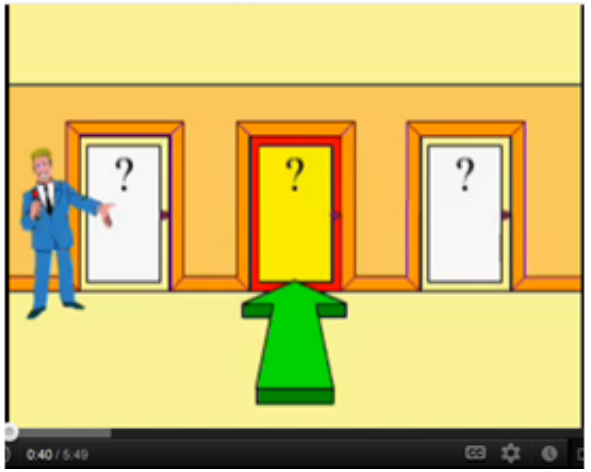


Results: Future Physics Teachers

A. Stick with the original choice
B. Swap doors
C. It doesn't matter

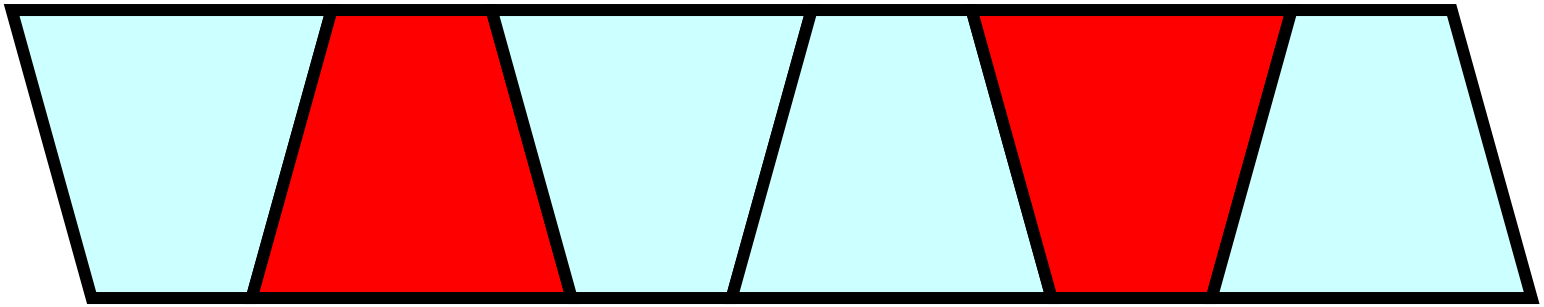






Q2: Engaging With Fractions

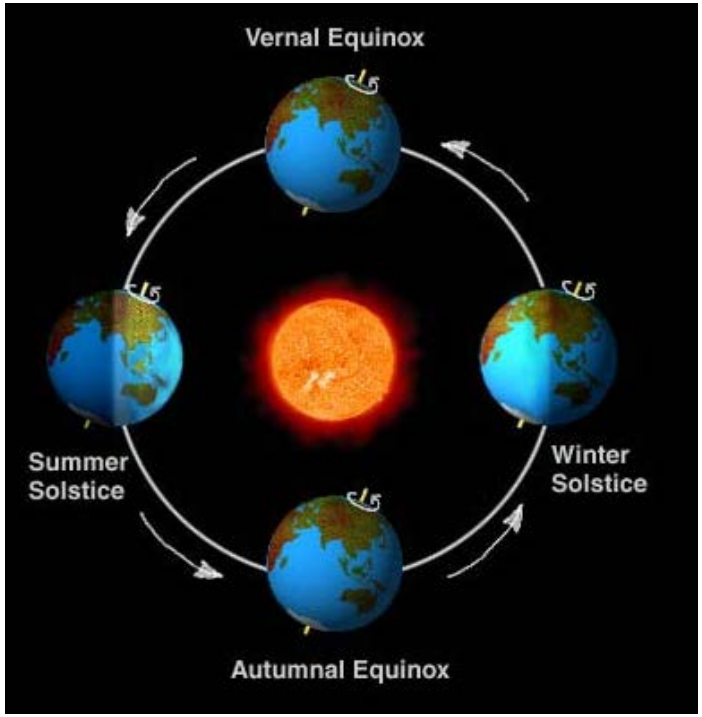
* What fraction of this shape is red?



A. $\frac{1}{2}$ B. $\frac{1}{3}$ C. $\frac{2}{3}$ D. $\frac{2}{6}$ E. $\frac{4}{6}$

Q3: What Causes Seasons?

A. The tilt of the Earth
B. The Earth-Sun distance
C. The weather patterns
D. The position of Sun spots
E. All of the above

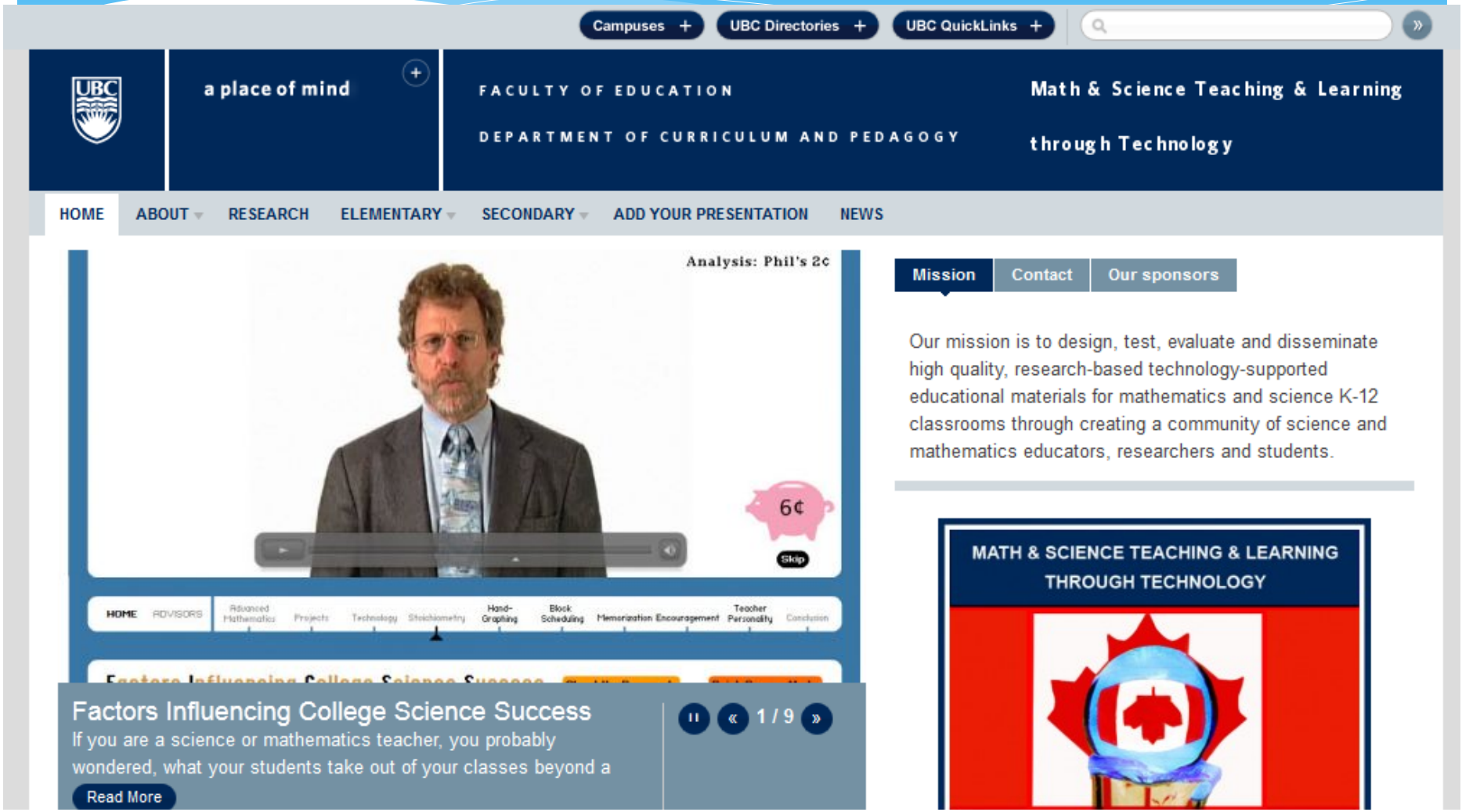


Q4: Why Does the Tilt Cause Seasons?

A. Because one part of the Earth gets closer to the Sun
B. Because the tilt changes the amount of direct light
C. Because the tilt and the clouds produce cooler weather
D. Because the tilt makes another of the Earth to be farther away from the Sun
E. Because the tilt prevents the Earth from absorbing Sun's Energy

What Constitutes a Powerful Clicker Question?

CLICKER QUESTIONS' DATABASE: http://scienceres-edcp-educ.sites.olt.ubc.ca/



Feedback from UBC Teacher-Candidates

I feel that the use of clickers in the classroom can keep a student remain anonymous. It reduces stress among students due to embarrassment of failure, and at the same time it helps instructor assess the success of the teaching strategies. Whereas, if they are simply asked if they have any questions or understood the concept, they might just nod without any understanding. It can give false expression of their understanding, mitigating their learning potential. Deep Kaur (EDCP 357)

Feedback from UBC Teacher-Candidates

I have found the conceptual clicker questions from your classroom to be probably the most useful and illuminating part of my classes. This format provides an environment in which the class feels comfortable investigating and exposing their prior knowledge about physics. (Adam Quiring).

The use of conceptual questions and clickers is very engaging and intellectually stimulating. The clickers create a safe learning environment where students do not have to fear giving an incorrect response to the teacher. I look forward to using this in my future classroom (Clement Law).

Activity: Asking Effective Clicker Questions (10 min)

Group activity: You plan a 45 min lesson on **a topic of your choice**. You have a class of 30 students and you want to use clickers.

Come up with three clicker questions at different levels in your discipline.

Why do you want to use them?

What are expected students' answers/difficulties?

What are you planning to do next?

II. Live Data Collection-Analysis

2007, Journal of College Science Teaching, 36(4), 45-49.

Can Students Learn from Lecture Demonstrations?

The Role and Place of Interactive Lecture Experiments in Large Introductory Science Courses

By Marina Milner-Bolotin, Andrzej

2008, The Physics Teacher, 46(8), 494-500.

Physics Exam Problems Reconsidered: *Using Logger Pro to Evaluate Student Understanding of Physics*

Marina Milner-Bolotin, Ryerson University, Toronto, ON

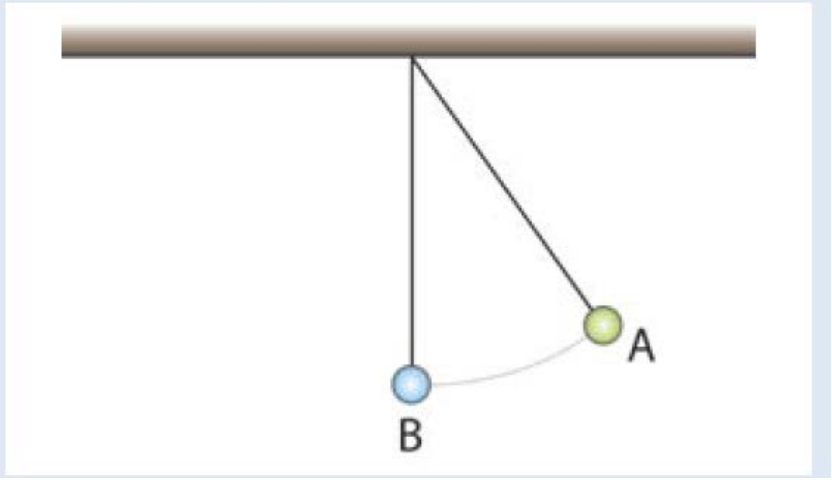
Rachel Moll, The University of British Columbia, Vancouver, BC

Using Live Data Collection

A 0.2-kg pendulum bob is attached to a string 1.2 m long. The bob is released at the point A as shown in the picture. The tension in the string as the bob passes its lowest position is about (use g = 10 m/s2):

(A) 0.00 N (B) 0.70 N (C) 1.30 N (D) 2.00 N (E) 2.70 N

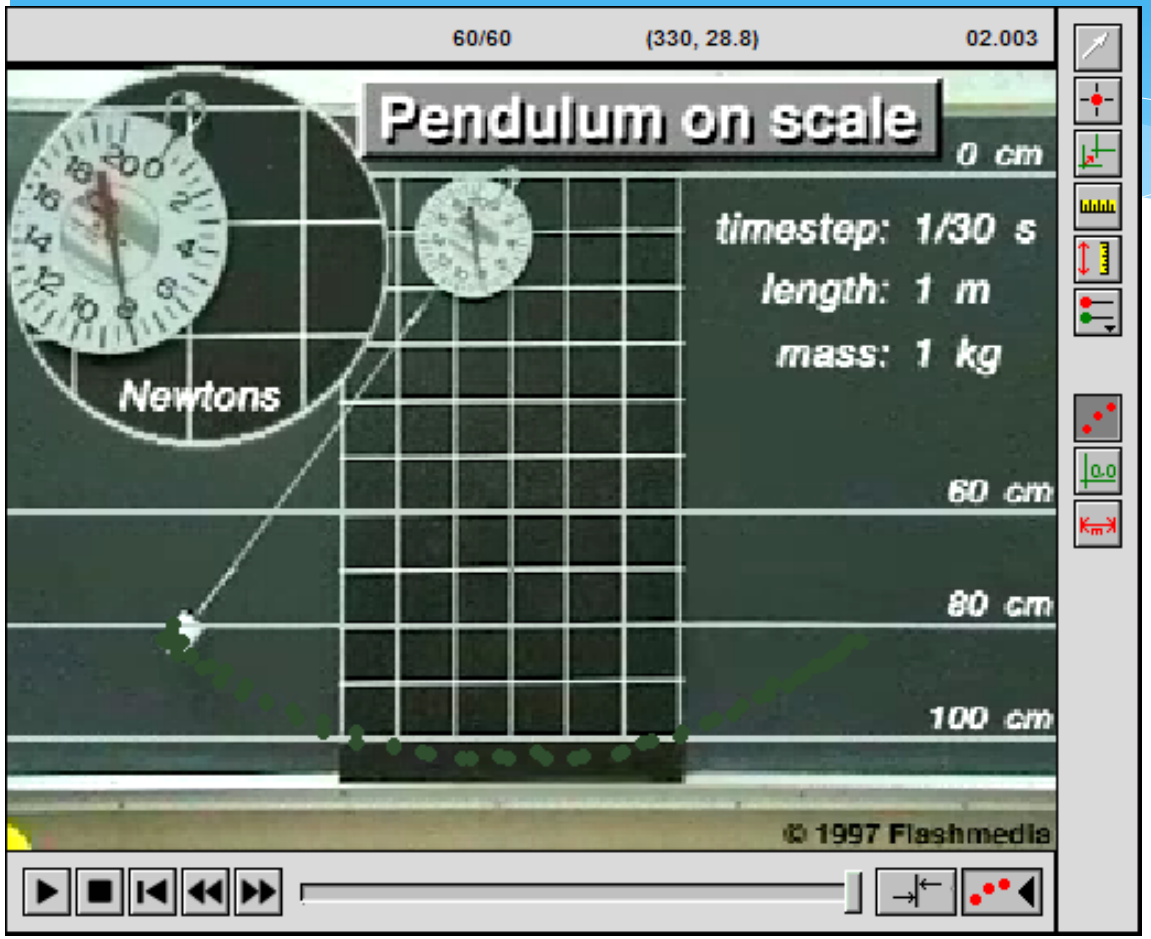
Tension in a pendulum's string exam problem.



Only 25% of the students chose the correct response. 59% chose the incorrect response (D).

M. Milner-Bolotin et al, Journal of College Science Teaching, January-February 2007, pp.45-49.

Pedagogy: Logger *Pro* Video Analysis



Students work in small groups, collect necessary data, come up with the analysis and solution and then check if their answer is meaningful using in-class live experiment (data collection).

Traditional lecture demonstrations are replaced by Interactive Lecture Experiments

Results

InterWrite PRS - Review Session: 11 15 2006 (Question Name: 'PRS 27-1: Pendul' Question

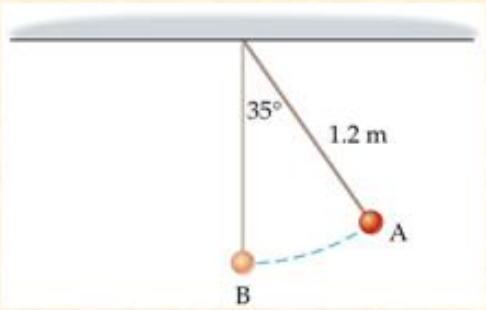
End Review | 1/6 | 217 | Mark Session

Q:

PRS 26-1: ILE 6 PENDULUM

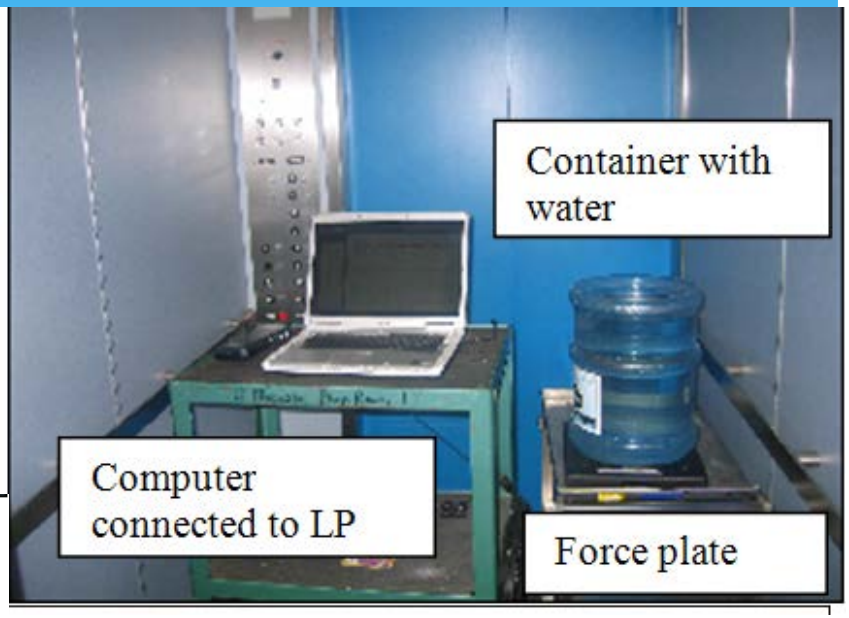
A 1-kg pendulum bob is attached to a string 1.2 m long. The bob is released at the point A as shown in the picture. The tension in the string as the bob passes its lowest position is about (use $g = 10$ m/s^2):

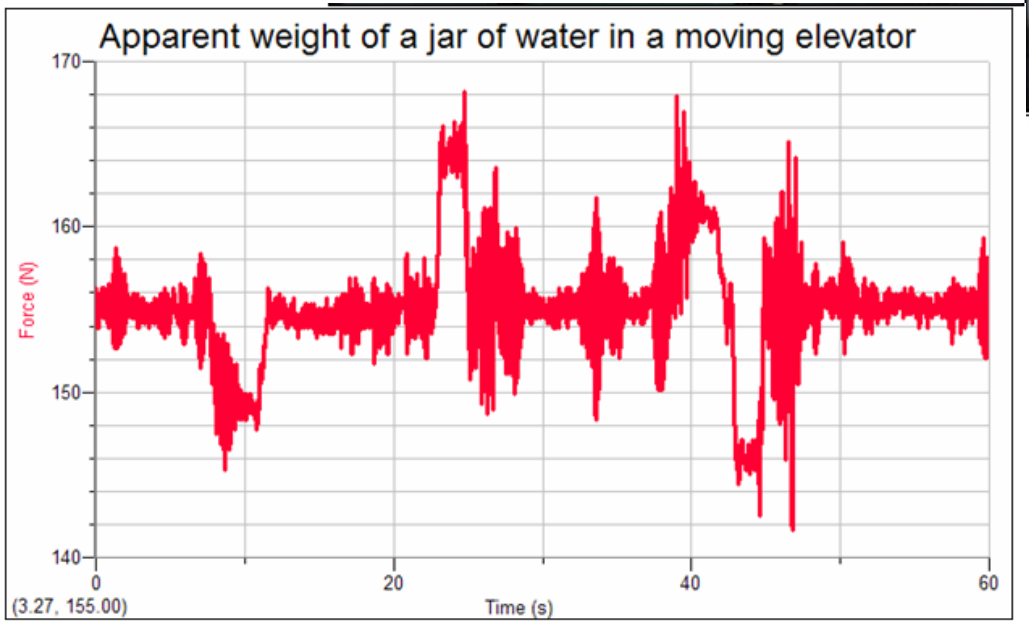
1. 13.0 N
2. 10.0 N
3. 6.5 N
4. 3.5 N
5. 0.0 N



Real Life HW & Exam Problems

Thinking like a scientist means being able to analyze real life situation using real data.

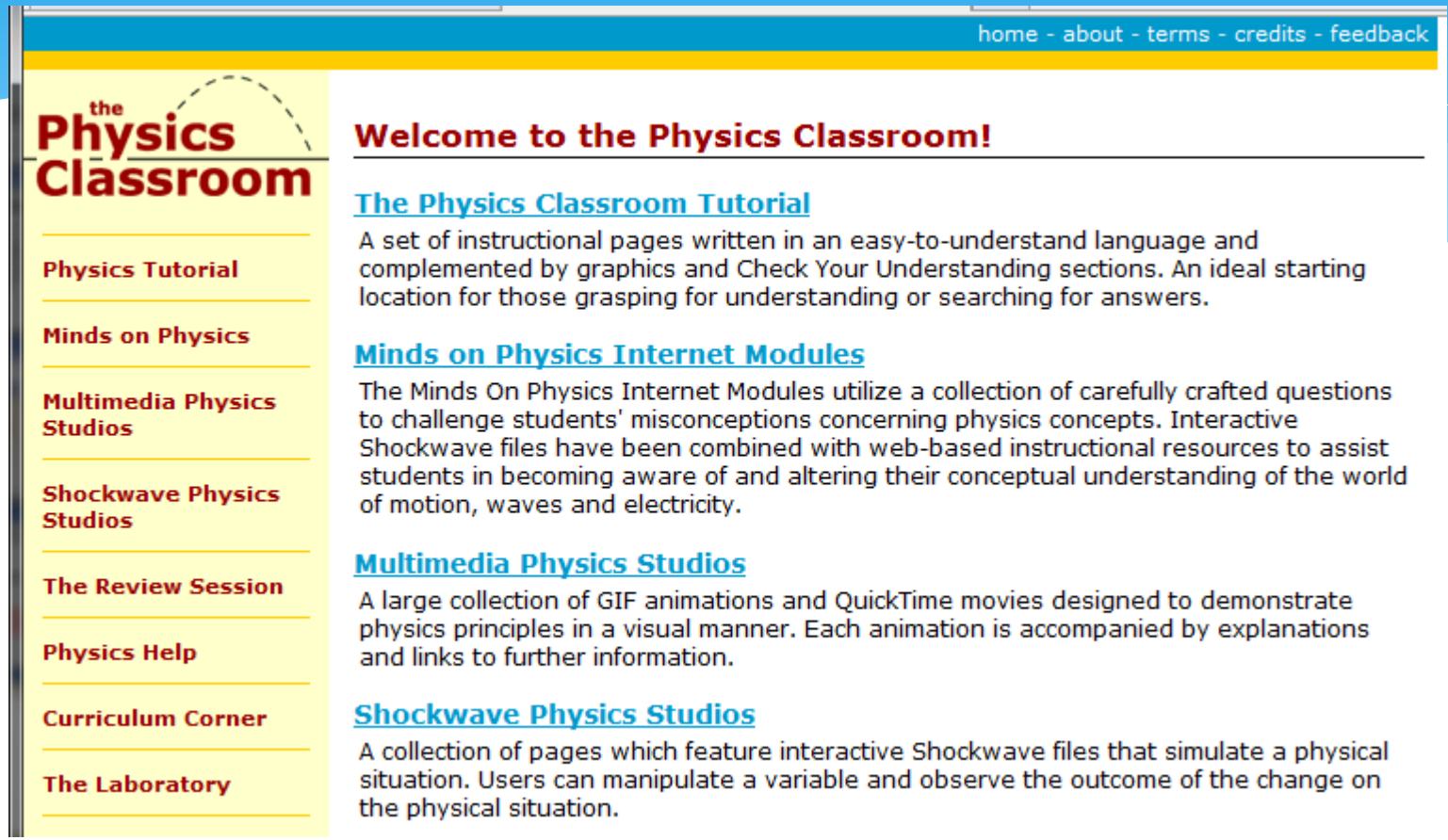




A water jar was placed on a force plate inside a moving elevator: weight and apparent weight problem

What Constitutes a Powerful Live Data Activity?

III. Using Computer Simulations



AAPT PHYSICS EDUCATION American Association of Physics Teachers

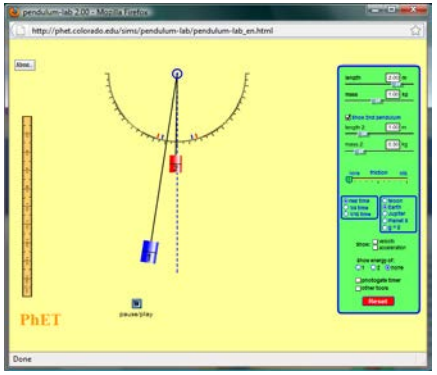
comPADRE Physics and Astronomy Education Communities

NSF

Developing Intuition & Visualization Skills

Developing intuition about physical phenomena via testing experimentally different scenarios which cannot be tested in the lab – WHAT IF…? For this to take place a teacher must **be able to design meaningful assignments**.

$$T = 2\pi\sqrt{\frac{l}{g}}$$



We can place the pendulum on the Moon, Earth, Jupiter or even Planet X…

Computer Simulations as a Pedagogical Tool

Protoplasma (2012) 249 (Suppl 1):S25–S30
DOI 10.1007/s00709-011-0346-6

REVIEW ARTICLE

The essence of student visual–spatial literacy and higher order thinking skills in undergraduate biology

Marina Milner-Bolotin · Samson Madera Nashon

Received: 11 June 2011 / Accepted: 17 October 2011 / Published online: 3 November 2011
© Springer-Verlag 2011

Abstract Science, engineering and mathematics-related disciplines have relied heavily on a researcher's ability to visualize phenomena under study and being able to link and superimpose various abstract and concrete representations including visual, spatial, and temporal. The spatial representations are especially important in all branches of biology (in developmental biology time becomes an important dimension), where 3D and often 4D representations are crucial for representations of scientific phenomena. This has been underscored by Richardson and Richardson (2002) who emphasize the increased importance of understanding 3D structure/function relationships to modern biochemistry and molecular biology. In highlighting this importance, Richardson and Richardson observe, "Not only are the overall "folds" that illuminate evolutionary relationships uncompromisingly three-dimensional but so, too, are the

What Constitutes a Powerful Simulation-Based Activity?

Inquiry in SMET Education

How do we engage future teachers in inquiry-based SMET Education?

By using inquiry in their methods courses…