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A Medley of Successful Active-Learning Methods

Sarah Formica
North Georgia College & State University

A Medley of Successful Active-Learning Methods in Introductory and Upper-Level Physics Courses

Sarah P. Formica
Associate Professor of Physics
North Georgia College & State University

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My Active-Learning Classroom

The Development of My Active Learning Classroom

- Began teaching at NGCSU in the Fall of 2005
- Attended AAPT New Physics Faculty Workshop in Fall 2006
  - Just-in-Time Teaching (JiTT)
  - Peer Instruction
  - Physlets, PHET Simlations
- Integrated JiTT, etc. into one class, Spring '07
  - All my classes, Fall '07
- AAPT New Physics Faculty Reunion, Fall 2010
  - Whiteboard Activities

How Would You Summarize JiTT?

- JiTT prepares the student and teacher for interactive learning about a concept etc that both have prepared to explore together. The student is asked to explore, prepare by reading etc and explaining what they already know or do not understand about the topic while the teacher must take this information and fit it for the class room activities. The classroom will be more interactive, student needs based and teacher involved with student learning needs.

How Would You Summarize JiTT?

- JiTT includes the use of assignments to ensure that students engage with the material before class. The instructor then uses this as input to her lesson design in order to more effectively use the class time. This allows the class to wrestle with the material that really needs that effort and time.

How Would You Summarize JiTT?

- JiTT is a teaching method based on web based study assignments and an active learner classroom. Students are asked to read and to answer questions (hence have to think) about the topics to be covered in class. The instructor then tailors the classroom lesson to their responses addressing the most common problems he found from their answers.

How Would You Summarize JiTT?

- Just-in-Time Teaching is getting immediate feedback on students' understanding of the material to be covered in class. It encourages students to look through the material prior to class and, hopefully, get more out the class upon arrival. In some ways, it teaches the student how to be a student.

Learning Goals for Your Students

- The main learning goal is to be able to understand the general concepts. This hinges on me being able to explain the concepts in a way that they can understand. The other goal is to be able to apply these concepts to solving problems.

- I do not bring any materials with me to complete the problems that we cover, so they must tell me how to do the problems or give the appropriate answer.

Learning Goals for Your Students

- Be able to explain, show or demonstrate to others the concepts or information learned.
- motivation, self-efficacy, study habits
- Being able to understand the concepts and translate this to solving problems.
- Having a good study habit/pattern.
- Getting the most out of the classroom time by being actively engaged and contributing to discussions/questions asked.
- Their desire to learn/be in the class

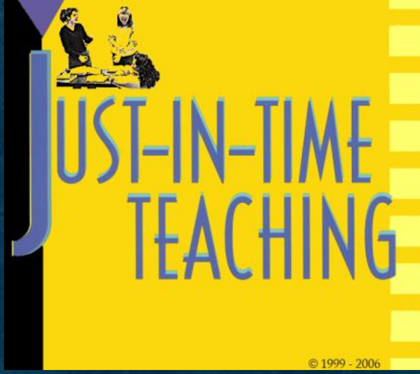
Learning Goals for Your Students

- Understand the basic concepts of the mathematics material so they may work alone or in groups outside the classroom to become successful on these concepts.

- Complete the home learning with at least an 80% success rate.

- Retain the materials for more than a day or two, mastery!!

Just-in-Time Teaching: JiTT



- Three Step Process
  1. "Warm Up" = assigned reading and online questions
  2. Class discussion of Warm Up
  3. Group activity to apply concepts
- Critical Thinking and Reflective Writing, even before coming to class
- Physical demos, experiments, simulations, problems, etc.
  - Critical thinking, complex problem solving, teamwork, creativity, quantitative reasoning

Lesson on Newton's Laws of Motion

- Newton's 1st Law (Law of Inertia)
  - An object in motion stays in motion, and an object at rest stays at rest, unless acted upon by an outside force.

- Warm Up Question:
  - Explain the need for automobile seatbelts in terms of Newton's 1st Law.

Lesson on Momentum Conservation

- Momentum Conservation:
  - In a system where the net force is zero, linear momentum of the system is conserved (does not change) in a collision or explosion.
- Linear momentum = mass × velocity
  - velocity is a vector quantity, so it has direction

Lesson on Momentum Conservation

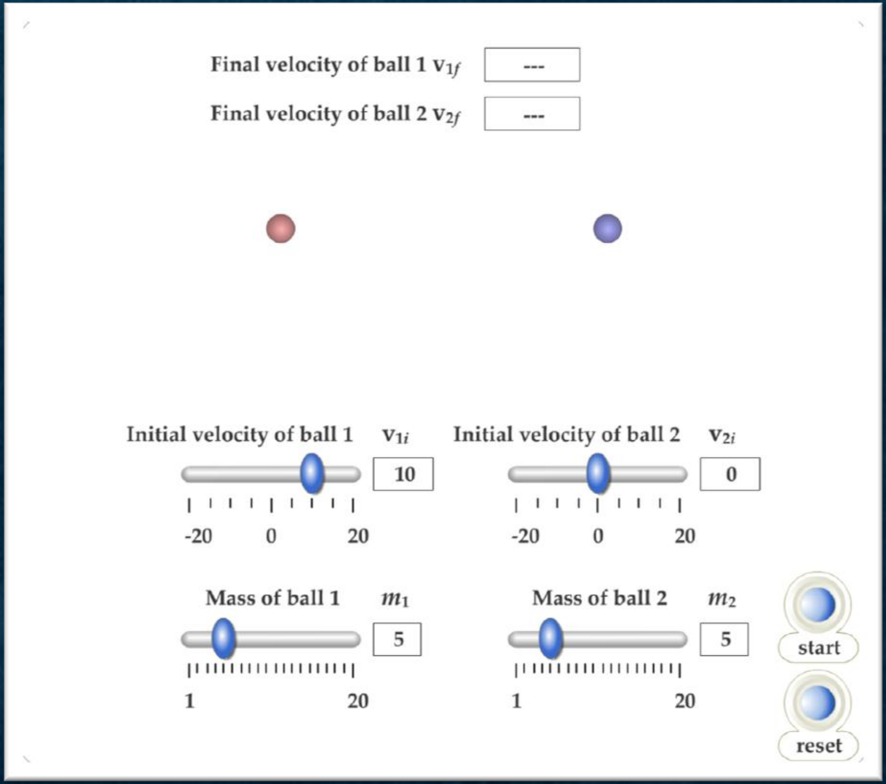
- Try your intuition on the following question and then test your answer by running the animation. If the two masses are equal, and ball 2 is initially at rest, upon collision:

① ball 1 bounces back with the negative of its initial velocity.

② ball 1 continues with half its initial velocity, and ball 2 also moves off with half the initial velocity of ball 1.

③ ball 1 stops, and ball 2 moves off with the initial velocity of ball 1.

④ ball 1 stops, and ball 2 moves off with twice the initial velocity of ball 1.



Lesson on Momentum Conservation

- Warm Up Question:
  - You are stranded at the center of a frozen lake (don't ask me how you got there). You can't walk off the lake because there is no static friction between your feet and the ice. When you try to slide to the shore, you remain in the same spot - again due to the lack of static friction. Fortunately, you are carrying your physics textbook. Explain how you can get off the lake and to the shore.

Lesson on Energy Conservation

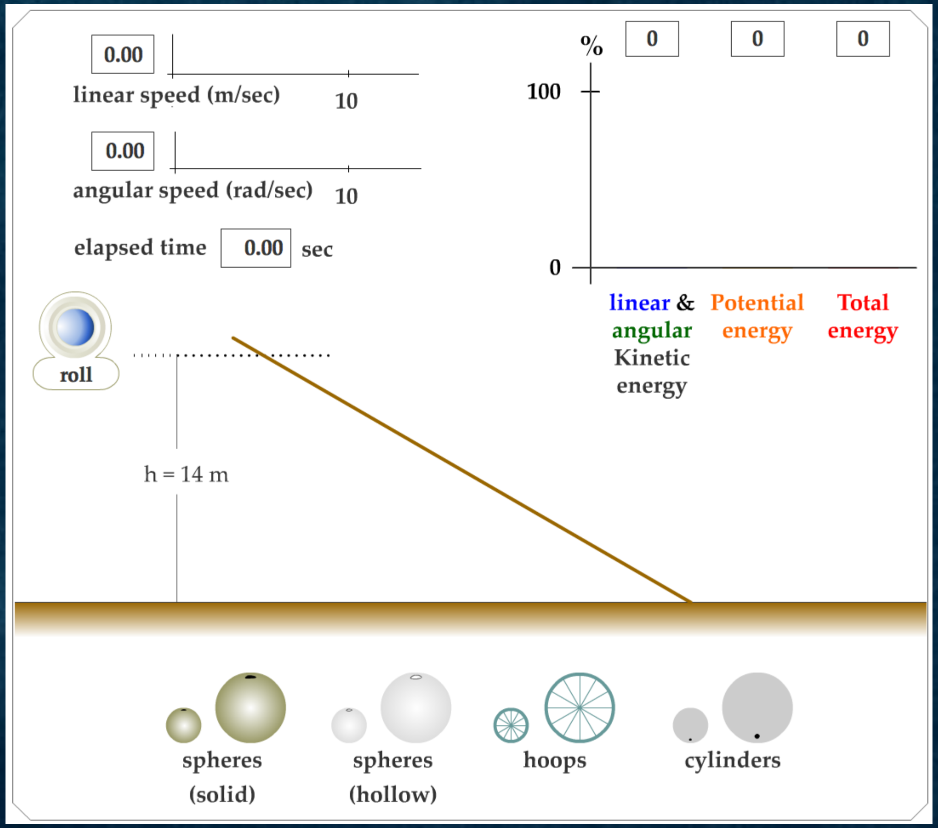
- Mechanical Energy Conservation
  - In a system where only conservative forces do work, the mechanical energy of the system is conserved (does not change) during some action or event.

- Mechanical Energy = Potential Energy + Kinetic Energy
  - This example: gravitational potential energy, translational (linear) kinetic energy, rotational (angular) kinetic energy

Lesson on Energy Conservation

- Test the effect of mass and radius for the same type of object: Run the animation for the smaller solid sphere, noting its linear and angular speeds at the bottom of the incline, and then repeat for the larger solid sphere.

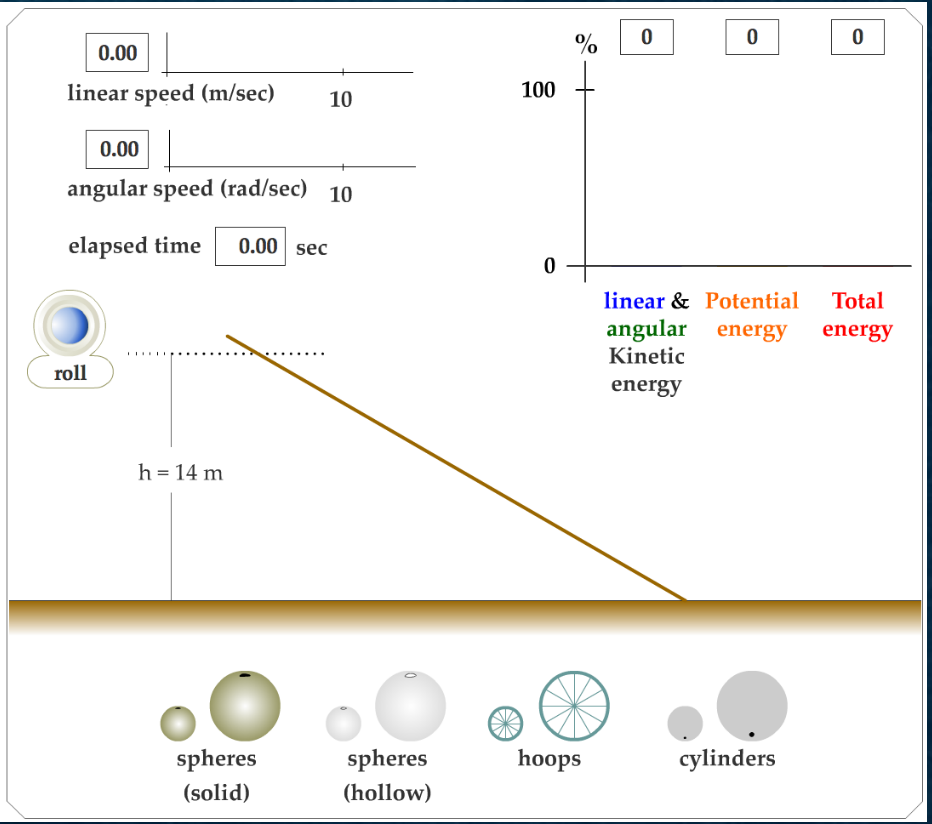
1. The linear speed is not affected by the mass and radius, while the angular speed is.
2. The angular speed is not affected by the mass and radius, while the linear speed is.
3. Both linear and angular speeds are affected by the mass and radius.
4. Neither linear nor angular speeds are affected by the mass and radius.



Lesson on Energy Conservation

- Test the effect of the distribution of mass: Run the animation for the larger solid sphere and the larger hollow sphere, noting the linear speed of each at the bottom of the incline and the ratio of linear to angular kinetic energy.

1. The solid sphere has the larger linear speed and a larger portion of the original PE went into linear KE.
2. The solid sphere has the smaller linear speed and a larger portion of the original PE went into linear KE.
3. The solid sphere has the larger linear speed and a smaller portion of the original PE went into linear KE.
4. The solid sphere has the smaller linear speed and a smaller portion of the original PE went into linear KE.



Lesson on Energy Conservation

- Warm Up Question:
  - A hoop and a disk, each of mass M and radius R, are released from rest at the top of a ramp of height h. Which will make it to the bottom of the ramp first, and why?

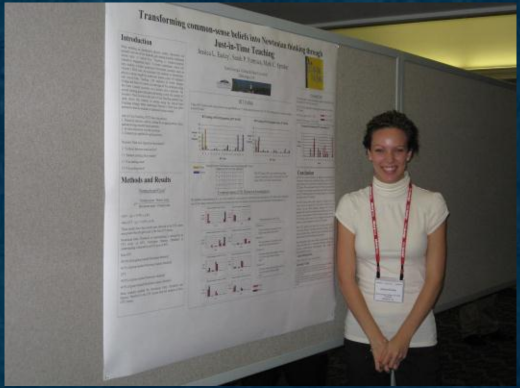
Lesson on Simple Harmonic Motion

- Warm Up Question:
  - A mass that is suspended from a spring with spring constant *k*, is pulled down to a point that is 5 cm below the equilibrium point and then released. Suppose the period of its motion, once released, is 0.5 seconds. If instead, the mass were pulled a distance 10 cm below the equilibrium point, what would be the period of its motion? Explain.

- http://phet.colorado.edu/sims/mass-spring-lab/mass-spring-lab_en.html

PER GANG Research

- Physics Education Research Group At North Georgia
- Two Groups:
  - JiTT → students taught by the JiTT method (N = 154)
  - Non-JiTT → students taught by more traditional methods (N = 124)
- FCI given as a pre-test and post-test



Jessica Easley, SESAPS 2008

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Normalized Gain on FCI

$$\langle g \rangle = \frac{posttest - pretest}{100 - pretest}$$

R.R. Hake, *American Journal of Physics*, 1998. Interactive-engagement vs traditional methods: A six-thousand- student survey of mechanics test data for introductory physics courses

JiTT: $\langle g \rangle = 37.9 \pm 2.0\%$

Non-JiTT: $\langle g \rangle = 16.2 \pm 2.4\%$

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Transforming common-sense beliefs into Newtonian thinking through Just-In-Time Teaching

Sarah P. Formica, Jessica L. Easley, and Mark C. Spraker
Department of Physics, North Georgia College & State University, Dahlonega, Georgia 30597, USA
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Normalized Gain on FCI

$$\langle g \rangle = \frac{posttest - pretest}{100 - pretest}$$

- Since incorporating whiteboard activities into my classes:

JiTT: <g> = 43%

Non-JiTT: <g> = 22%

What the Students Say

- "I enjoyed this course very much; the homework assignments contributed towards learning the material and helping on tests. The thing I enjoyed the most were the programs used on the computer that related to the material we discussed; those were quite interesting. Overall, the course was very entertaining and interesting."

- PHYS 2211, Spring 2008

What the Students Say

- "I absolutely loved being in Doctor Formica's class. I wish that I had more Physics classes to take so that I could have her as a teacher again. She is very interactive with the material and sets the students up for success. I have recommended her to everyone I have talked to that needs to take Physics."

- PHYS 2212, Fall 2011

What the Students Say

- "Dr. Formica's classes are always tough but interesting. This was my favorite of 3 that I've had with her. She encourages class participation by giving students an opportunity to work together to solve problems presented during lecture, which helps build communication and teamwork skills."

- PHYS 3310, Fall 2011

What the Students Say

- "Dr. Formica made physics understandable and fun. I feel like I learned more in this class than in any class I've taken this semester. This class made me enjoy physics and actually made me want to change my major so I could include more physics in my curriculum."
- PHYS 1111, Fall 2007

Some of Your Concerns

- My main concern is the time involved in reading the students responses and preparing a lesson plan based on this especially if the warm ups are to be given for every class. I see this being an issue for a large class.

A few FAQs

- Why do the students buy in?
  - Receive small credit for effort
  - Community effort – feel left out if they don't participate
  - Benefits them to ask questions – they get answers right away
- How much time does JiTT take?
  - About 20 min for students
  - About 30 minutes for teachers (~ 30 students/class)

Your Breakout Session

- Break into small groups (~ 3 people / group)
  1. Decide on a topic that might be covered in one of your courses
  2. Come up with at least 3 WarmUp questions you might use with the above topic
  3. Design a class activity related to the topic and the WarmUp questions
- Share your new ideas with the other groups

Resources

- JiTT digital library: www.jittdl.org
- Peer Instruction: www.peerinstruction.net/
- PHET Simulations: phet.colorado.edu/
- Whiteboard Activities: www.physics.oregonstate.edu/portfolioswiki/
- Online Homework System: www.webassign.net/