Thinking broadly about educational technology

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CSUSM IITS

Hewlett Packard Technology for Teaching
Microsoft External Research

Ed Price, APS Experienced Faculty
Workshop, April 2013

I believe that the motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of textbooks.

The education of the future, as I see it, will be conducted through the medium of the motion picture… where it should be possible to obtain 100% efficiency.

Thomas Edison, 1922

Cuban, Larry. *Teachers and Machines: The Classroom Use of Technology Since 1920.*

Typical classroom- today

Earliest known example of a school-room from Sumer, circa 3000 BC

Will computers 'fix' education?

What do we mean by learning?

Knowledge
Comprehension
Application
Analysis
Synthesis
Evaluation

Problem solving
Communication
Collaboration
Management of complex tasks
Nature of science

- Before thinking about technology specifically, what do we know about teaching/learning?
- What are our goals?

POLICY FORUM

EDUCATION

Scientific Teaching

Jo Handelsman,[1*] Diane Ebert-May,[2] Robert Beichner,[3] Peter Bruns,[4]
Amy Chang,[5] Robert DeHaan,[6,†] Jim Gentile,[7] Sarah Lauffer,[1]
James Stewart,[8] Shirley M. Tilghman,[9] William B. Wood[10]

Since publication of the AAAS 1989 report "Science for all Americans" (*1*), commissions, panels, and working groups have agreed that reform in science education should be founded on "scientific

do scientific teaching, as we do with supporting online material (SOM) (*3*) and table (see page 522). We also present recommendations for moving the revolution forward.

wide range of institutions demonstrated better problem-solving ability, conceptual understanding, and success in subsequent courses compared with students who had learned in traditional, passive formats (*3*).

These results are neither isolated nor discipline-specific. At the University of Oregon, Udovic showed dramatic differences between students taught biology in a traditional lecture and those taught "Workshop Biology," a series of active, inquiry-based learning modules (*6*). Similarly impressive results were achieved by Wright in

Scientific teaching involves active learning strategies to engage students in the process of science and teaching methods that have been systematically tested and shown to reach diverse students

Learning principles

1. Learning builds on prior knowledge
2. Learning is a complex process requiring scaffolding
3. Learning is facilitated through interaction with tools
4. Learning is facilitated through peer interactions
5. Learning is facilitated through establishment of norms and expectations

J. D. Bransford, A. L. Brown, and R. R. Cocking, *How People Learn: Brain, Mind, Experience, and School* (NAP, Washington, D.C., 2000).
E. F. Redish, Implications of Cognitive Studies for Teaching Physics, American Journal of Physics **62**, 796 (1994).
D. Hammer, et al., in *Transfer of Learning: Research and Perspectives*, edited by J. Mestre (Information Age Publishing, 2004).
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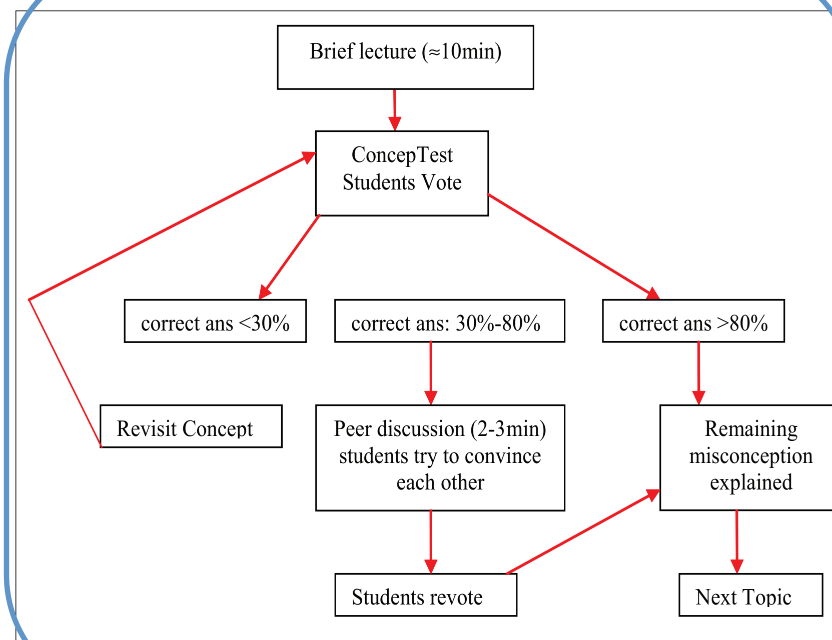
L. S. Vygotsky, *Thought and Language* (MIT Press, Cambridge, MA, 1986).
E. G. Cohen, *Designing Groupwork: Strategies for the Heterogeneous Classroom* (Teachers College Press, 1994), p. 203.
R. Driver, P. Newton, and J. Osborne, Establishing the Norms of Scientific Argumentation in Classrooms, Science Education **84**, 287-312 (2000).

- Where does technology come in?
- How can we think about how technology gets used and changes the classroom?

What do we do with clickers?

Technology ≠ pedagogy



Mazur, *Peer Instruction* (1997) Beaty & Gerace 2009; Lasry, 2008;

Clickers vs how we use them

Clickers as a tool

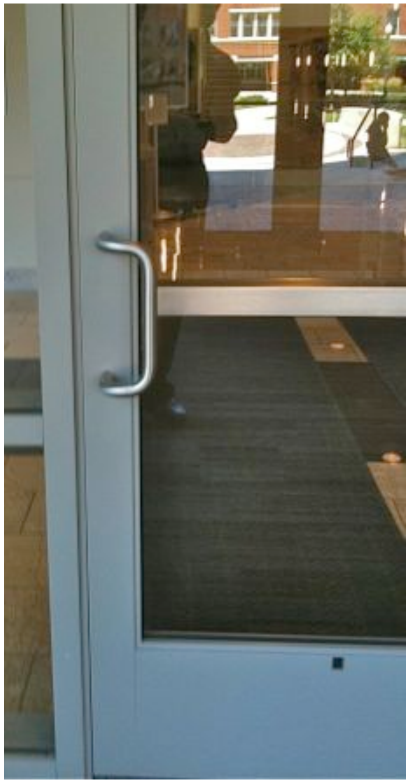
- Fast, easy, private
- Limited answer choices
- Response from all students
- Formalize participation
- Automate sharing
- Provide referent for discussion
- Save data for review, grading, research

Pedagogies featuring class response

- Reading quizzes
- In class conceptual questions
- Peer Instruction (Mazur)
- Question sequences (Bao)
- Question driven instruction (Beatty)

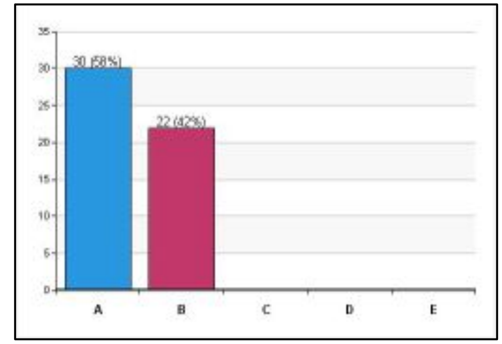
Beaty & Gerace 2009; Lasry, 2008; Mazur, 1997; Reay, Li, & Bao, 2008

Thinking about tools



Thinking about tools

- Affordances
- Constraints
- Tools *shape* what we do
- Enable new possibilities
- Not deterministic



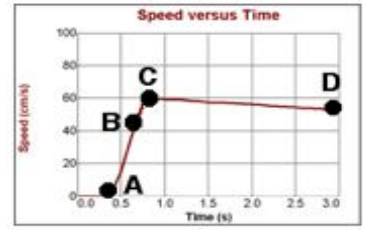
Finkelstein, et al., 2005; Lasry, 2008; Norman, 1988; Thornton & Sokoloff, 1990

Tools & pedagogy… is that it?

- Norms
  - sense making
  - responsibility for generating ideas
  - responsibility for evaluating ideas
- Roles
  - Who does what
- Instructor actions, grading practices lead to norms, perceived by students
- Classrooms/instructors have variation in norms and practices
- Implications for feedback and how it is used

James & Willoughby, 2011; Turpen & Finkelstein, 2010

Small Group Discussion



A framework for thinking about the physics classroom

A student learning physics is engaged in an activity as…

part of a community…	(Other students, instructor)
with rules/norms…	(How do things work here?)
and roles…	(Who does what?)
using tools…	("Technology" but also representations, language, etc)

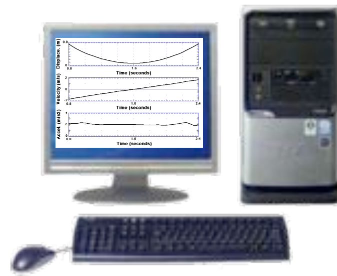
In a broader context

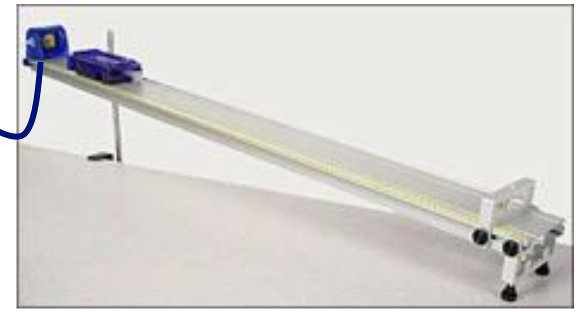
Cole, 1996; Engeström, 1987; Kaptelinin & Nardi, 2006; Nardi, 1996

YOUR TURN

For MBL and/or simulations…

- How does the use of this tool relate to your goals?
- For the ways you (might) use them, how does the tool
  - Reorganize who does what?
  - Change participation?
  - Allow new/different norms?
  - Reinforce/support existing norms?





Finkelstein, et al., 2005; Lasry, 2008; Norman, 1988; Thornton & Sokoloff, 1990

A whiteboard-intensive physics class

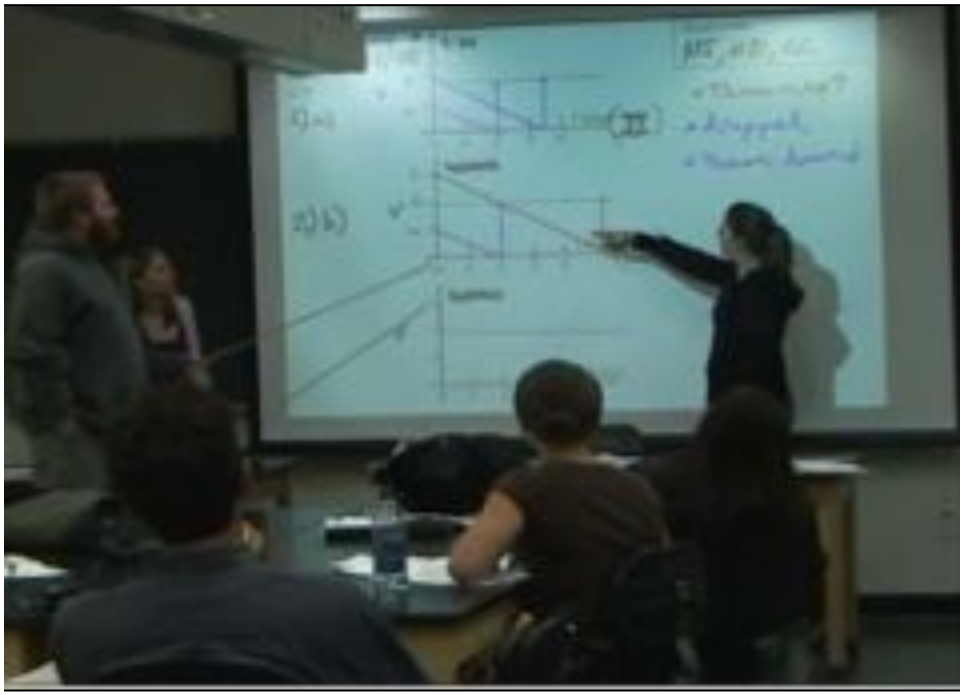
Whiteboards provide good collaborative space, but are volatile and fixed in size

Tablets as digital whiteboards

- Student groups use Tablet PCs and work on slides prepared by the instructor
- Student slides can be projected for whole class discussion and are archived on the web

Price & Simon, 2009

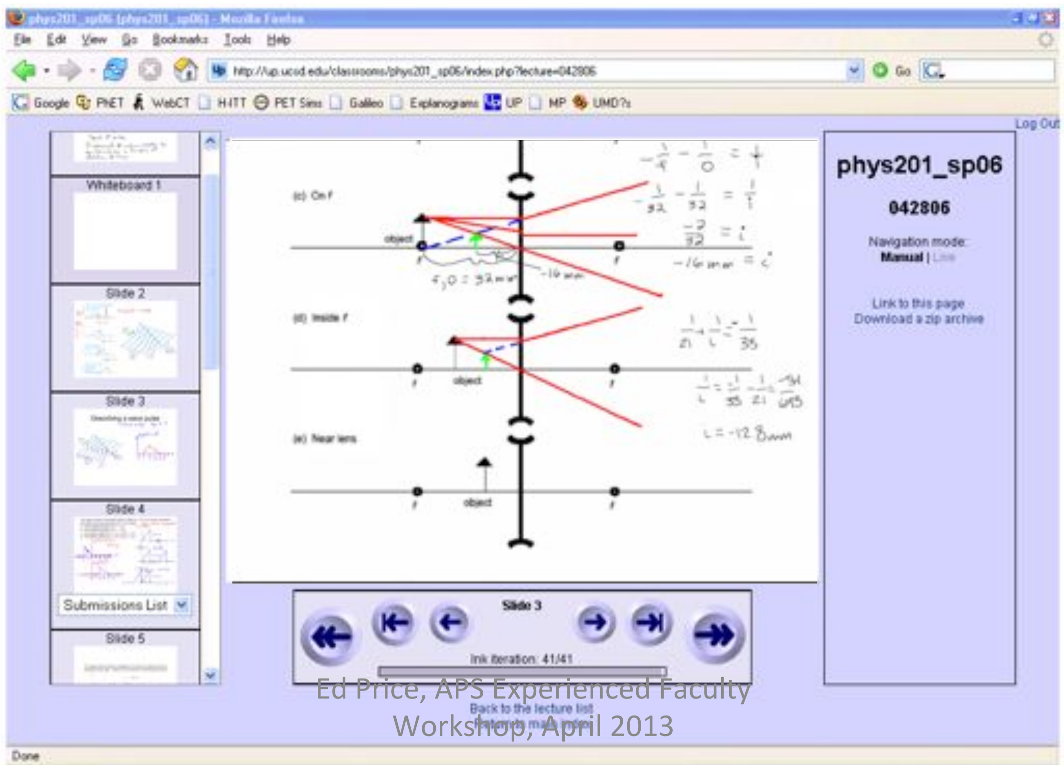
Projecting student work during whole class discussion



Archiving student work

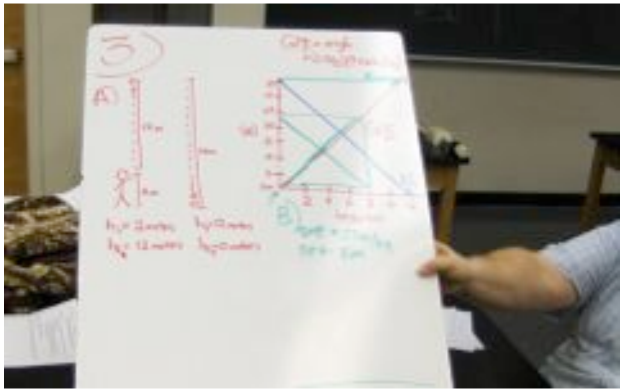
Students found online archive very useful, many page views, including student solutions

We had lots of ideas for how to use this to close the loop, but…



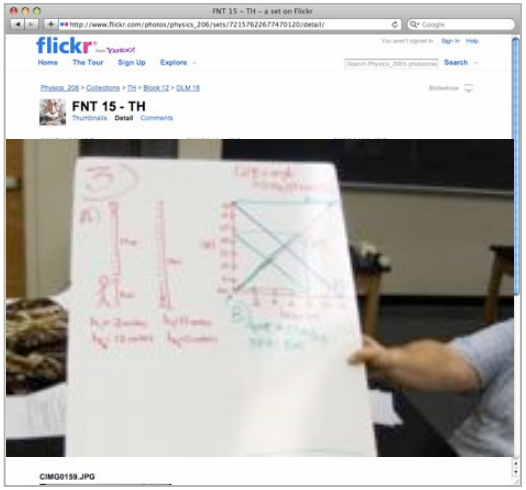
Tablets and collaboration

Digital photographs and Flickr.com



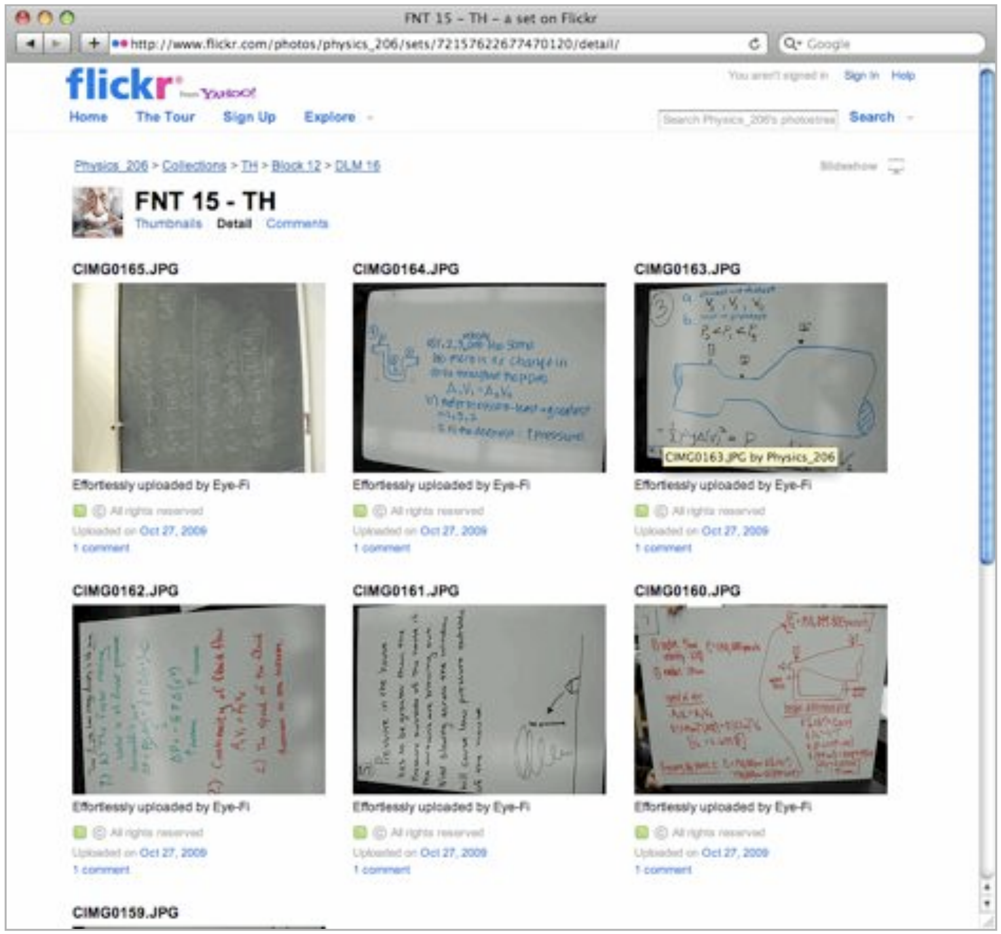
Whiteboards + archiving

- Cameras w/ wireless-enabled SD cards
- Course-specific Flickr account
- Images can be organized
- Tags and comments



Price, 2011

Students find online archive very useful, many hits before quizzes, emphasis on student work



Feedback and revising thinking

Before Flickr was used

– Student work was seldom edited after the class discussions.

With Flickr archive

– Students began to edit whiteboards after whole class presentations… "fixing" mistakes

– The photo now captured an edited solution

“Closing the loop”

- Photographing whiteboards motivated a final round of instructor feedback and student revision.
- Unintended and unexpected
- Students now take responsibility for evaluating, correcting their work
- Arose from student interest in their work as a resource, facilitated by the technology

YOUR TURN AGAIN

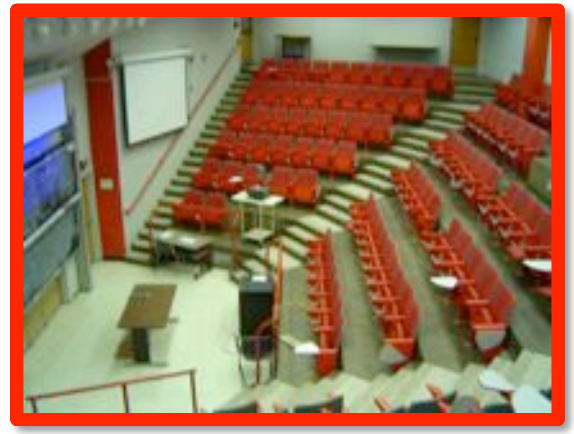
For online homework systems

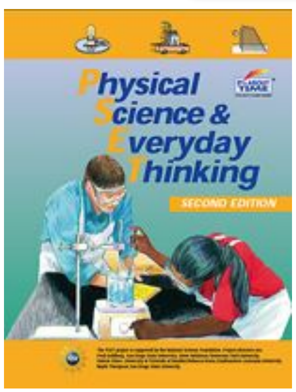
- How does the use of this tool relate to your goals?
- For the ways you (might) use them, how does the tool
  - Reorganize who does what?
  - Change participation?
  - Allow new/different norms?
  - Reinforce/support existing norms?

STUDENTS' WRITING OF SCIENTIFIC EXPLANATIONS IN A LARGE CLASS

Ed Price, APS Experienced Faculty
Workshop, April 2013

Adapting a small, discussion-lab course to large, lecture format

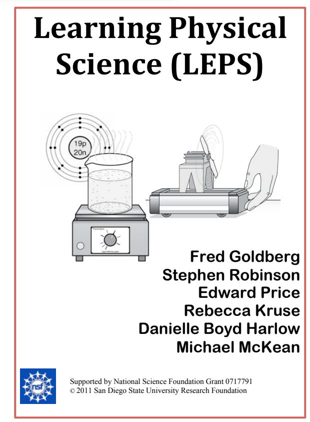




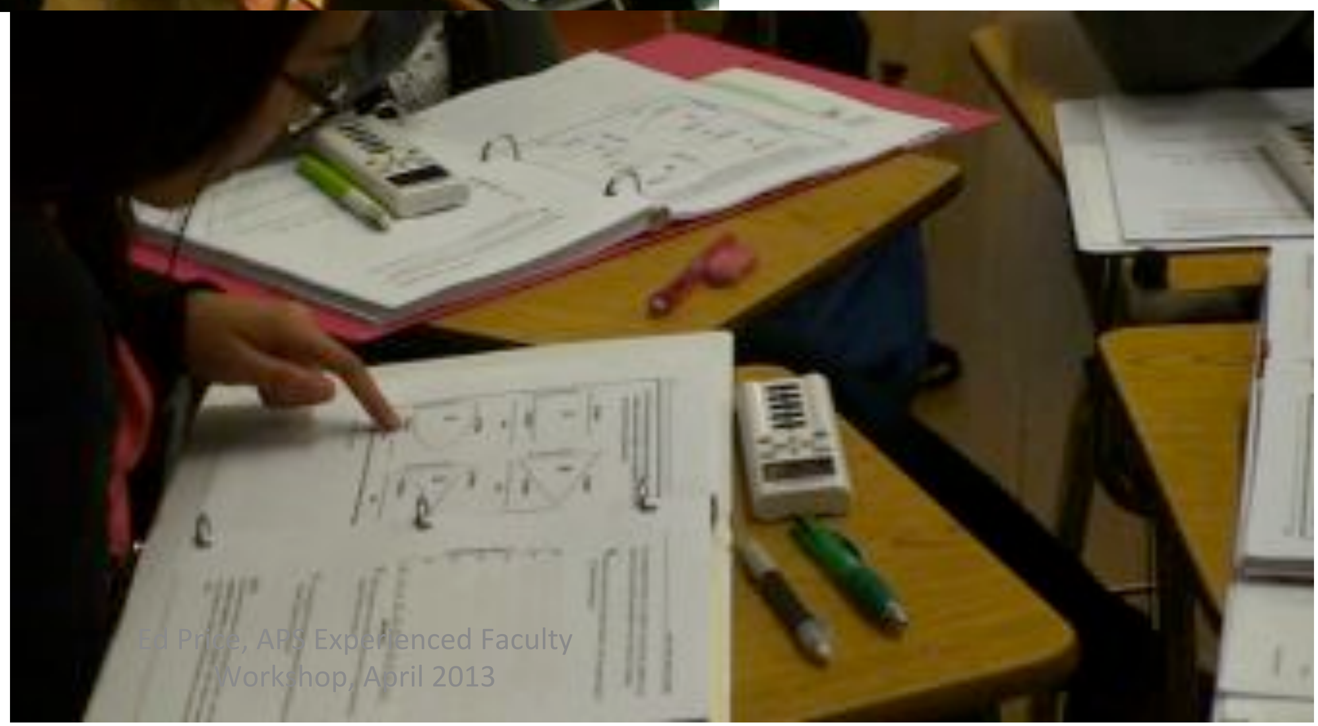
Can we do this?

What does it look like?

Does it work?



Development supported by NSF ESI-0096856 and DUE-0717791



Calibrated Peer Review

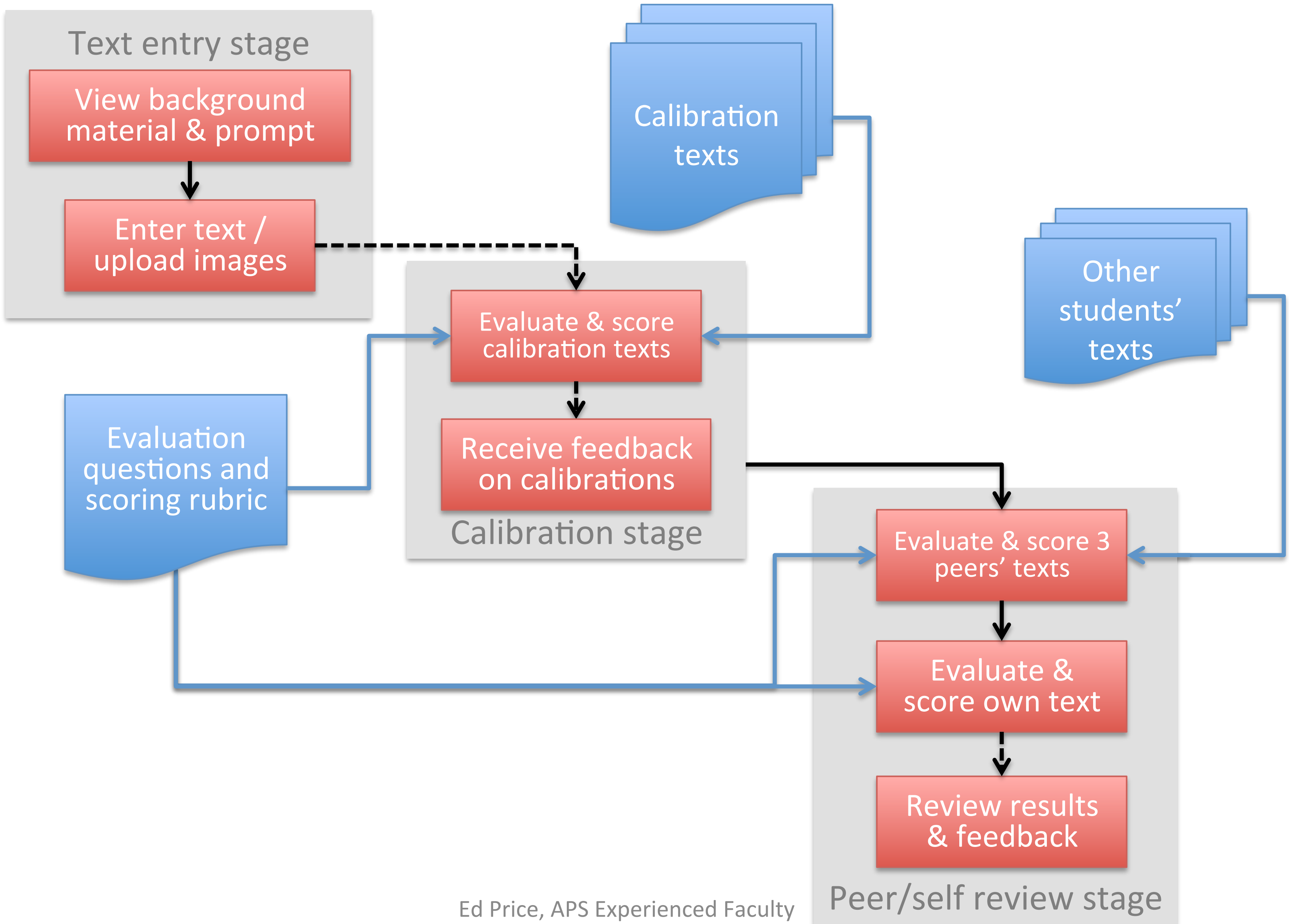
A web-based tool that supports students' construction and evaluation of explanations.

3 stages:

1. Text entry
2. Calibration
3. Peer review

CPR was developed at UCLA http://cpr.molsci.ucla.edu/Home.aspx

Calibrated Peer Review

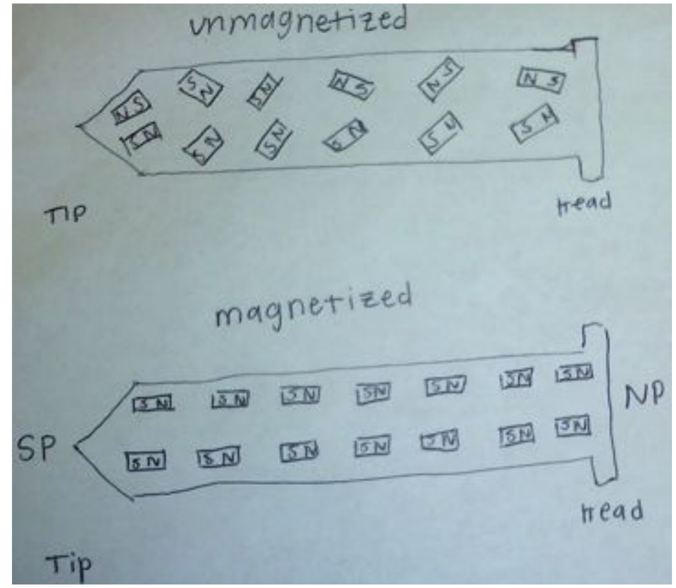


Ed Price, APS Experienced Faculty Workshop, April 2013

Price, Goldberg, et al. 2012

CPR Task Example

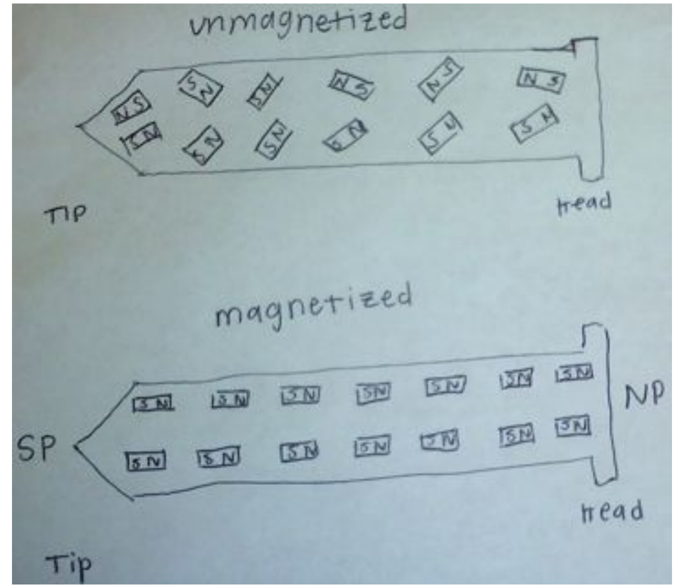
CPR Task Students use an alignment model of magnetism to explain a nail's being magnetized by a magnet, and demagnetized after being hit with a hammer.



In my diagram, I drew an unmagnetized nail by randomly orienting the tiny magnets inside the nail. The nail is unmagnetized because the magnetic effects due to the random collection of tiny magnets cancel each other out producing no magnetic effect.

Hammering made the nail become unmagnetized because when the hammer smashed the magnetized nail with all the tiny magnets perfectly aligned, the tiny magnets became randomly oriented again canceling each other out and producing no magnetic effect.

CPR Task Example



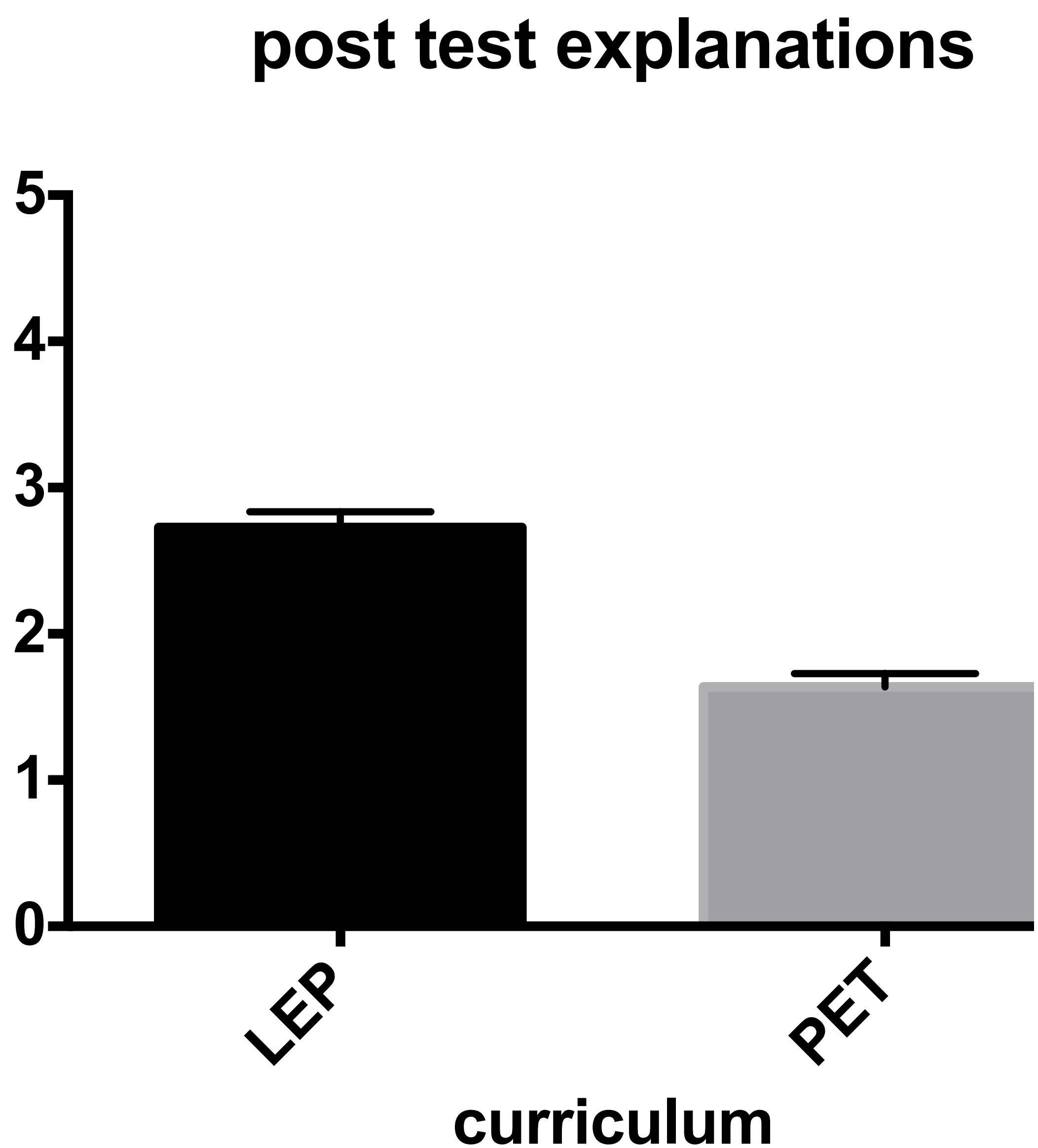
Evaluation questions:
"Does the first paragraph correctly describe that within the unmagnetized nail there are (many) tiny magnets that are randomly oriented; that is, their NPs (or SPs) point in different directions, or something similar?"

In my diagram, I drew an unmagnetized nail by randomly orienting the tiny magnets inside the nail. The nail is unmagnetized because the magnetic effects due to the random collection of tiny magnets cancel each other out producing no magnetic effect.

Hammering made the nail become unmagnetized because when the hammer smashed the magnetized nail with all the tiny magnets perfectly aligned, the tiny magnets became randomly oriented again canceling each other out and producing no magnetic effect.

Writing scientific explanations – average final exam performance of students in two types of courses

Students in courses that included 5 CPR tasks (LEP) outperformed students in courses with traditional assignments (PET)



Price, Goldberg, et al., in preparation

CPR as a tool

- Supports goal of students being able to construct, critically evaluate explanations
- With CPR,
  - Instructor as developer, but students as graders/evaluators
  - Task development is intensive, but grading/administration is minimal
  - Implicit suggestion that students can develop (some) expertise

FLIPPING THE CLASSROOM

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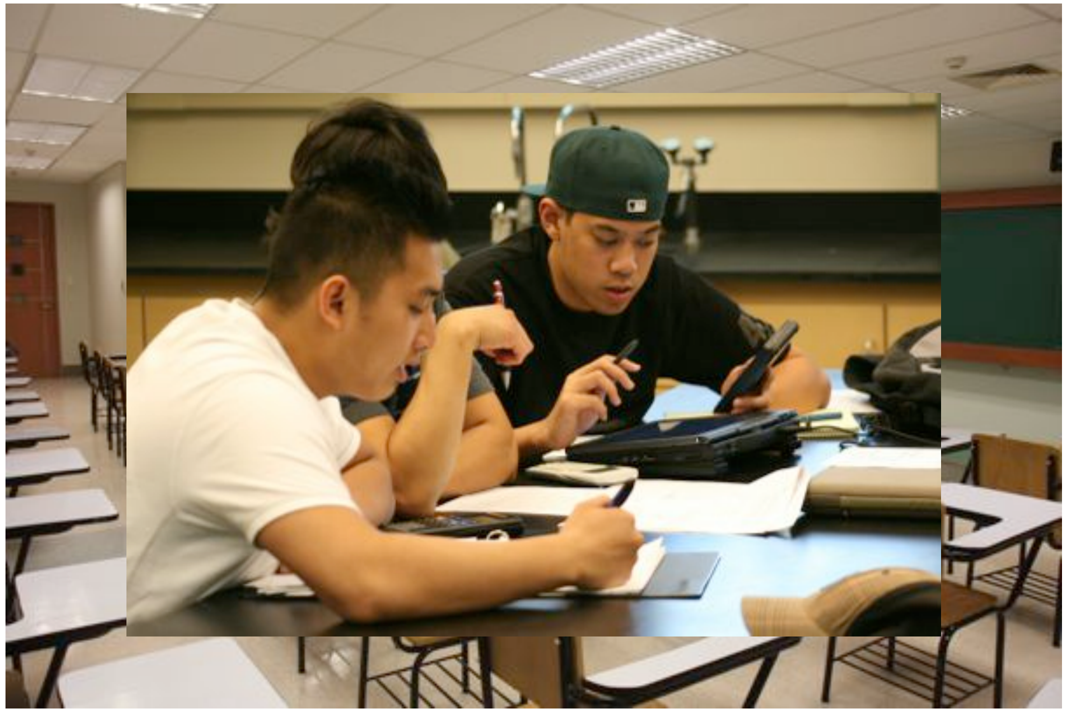

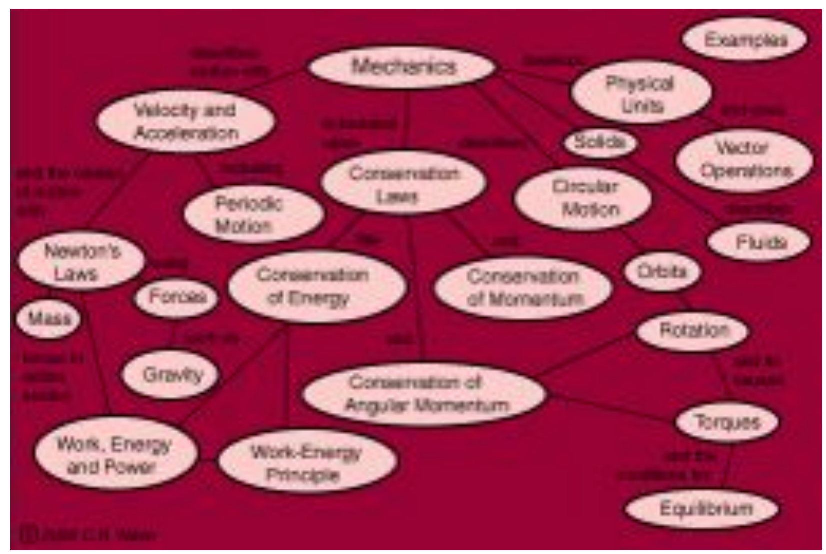
Mechanics
Examples
Physical Units
Velocity and Acceleration
Solids
Vector Operations
Conservation Laws
Circular Motion
Periodic Motion
Fluids
Newton's Laws
Orbits
Conservation of Energy
Conservation of Momentum
Forces
Mass
Rotation
Gravity
Conservation of Angular Momentum
Torques
Work, Energy and Power
Work-Energy Principle
Equilibrium


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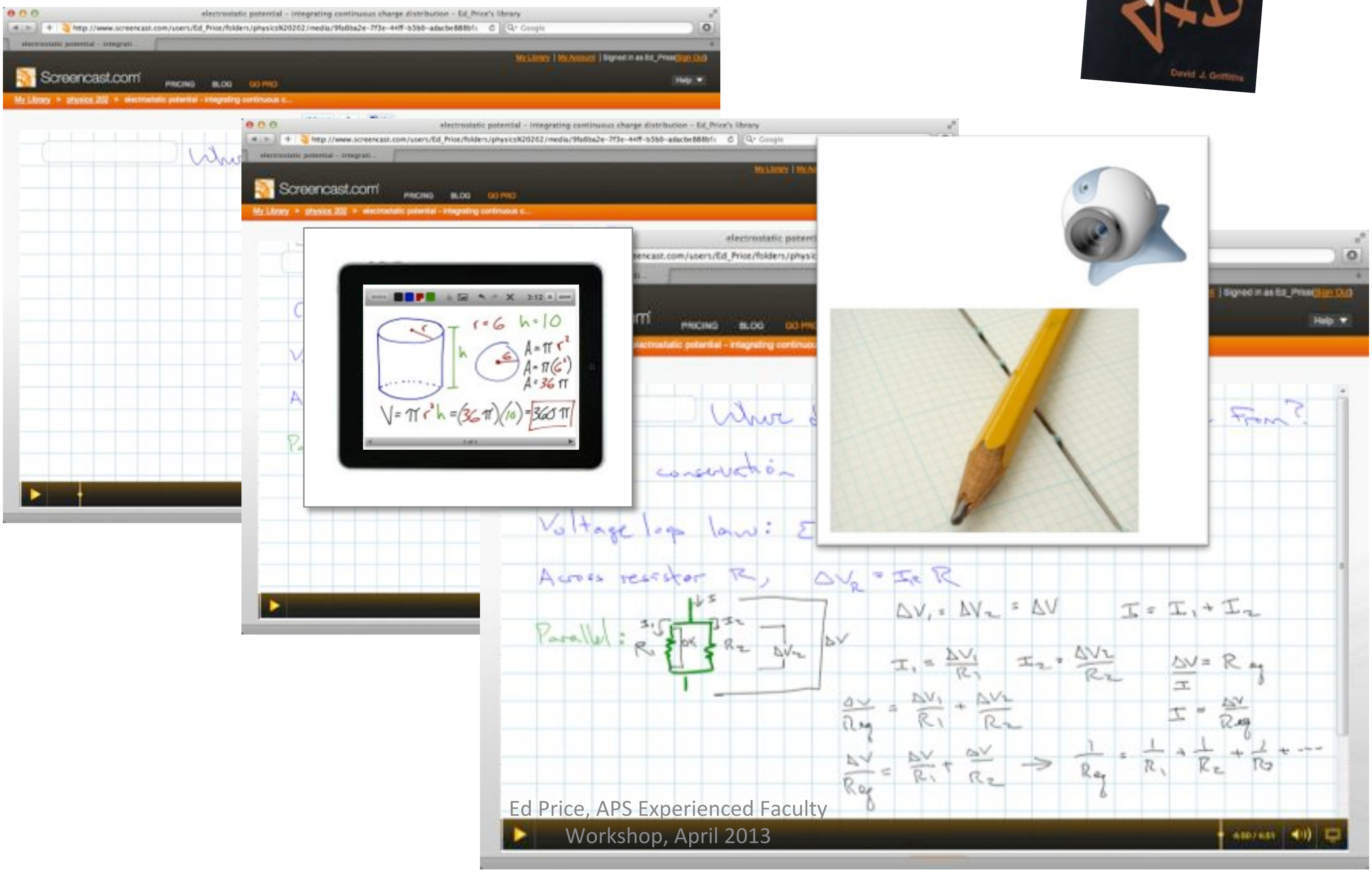
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BLOG
GO PRO
What
conservation
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Across resistor R,
Parallel:
r=6 h=10
$A=\pi r^2$
$V=\pi r^2 h=(36\pi)(10)=360\pi$

For screencasts (and books) and flipped classrooms?

- How does the use of this tool relate to your goals?
- For the ways you (might) use them, how do these tools
  - Reorganize who does what?
  - Change participation?
  - Allow new/different norms?
  - Reinforce/support existing norms?

MOOCS, ONLINE COURSES, & THE WHOLE FUTURE OF EDUCATION

Ed Price, APS Experienced Faculty
Workshop, April 2013

The New York Times

Education

March 4, 2012

Instruction for Masses Knocks Down Campus Walls

By TAMAR LEWIN

The pitch for the online course sounds like a late-night television ad, or maybe a subway poster: "Learn programming in seven weeks starting Feb. 20. We'll teach you enough about computer science that you can build a Web search engine like Google or Yahoo."

But this course, Building a Search Engine, is taught by two prominent computer scientists, Sebastian Thrun, a Stanford research professor and Google fellow, and David Evans, a professor on leave from the University of Virginia.

The big names have been a big draw. Since Udacity, the for-profit startup running the course, opened registration on Jan. 23, more than 90,000 students have enrolled in the search-engine course and another taught by Mr. Thrun, who led the development of Google's self-driving car.

Learning principles

1. Learning builds on prior knowledge
2. Learning is a complex process requiring scaffolding
3. Learning is facilitated through interaction with tools
4. Learning is facilitated through peer interactions
5. Learning is facilitated through establishment of norms and expectations

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R. Driver, P. Newton, and J. Osborne, Establishing the Norms of Scientific Argumentation in Classrooms, Science Education **84**, 287-312 (2000).

U.S. DEPARTMENT OF EDUCATION

Evaluation of Evidence-Based Practices in Online Learning

A Meta-Analysis and Review of Online Learning Studies

Students who took all or part of their class online performed better, on average, than those taking the same course through traditional face-to-face instruction. Learning

[differences] may be the product of aspects of those treatment conditions other than the instructional delivery medium per se.

51 contrasts is statistically significant at the $p < .01$ level. Interpretations of this result, however, should take into consideration the fact that online and face-to-face conditions generally differed on multiple dimensions, including the amount of time that learners spent on task. The advantages observed for online learning conditions therefore may be the product of aspects of those treatment conditions other than the instructional delivery medium per se.

The Cow Tipping Point

I propose to widen the context gradually so that we always know the vantage point from which we are viewing the [physics education] landscape. Eventually, the basic truths of the matter should be fairly clear, if they aren't already; and the conclusions we ought to reach about the technology will be obvious. … As we move further and further from the original narrow context, we gradually leave the realm of science and medicine and we enter the territory of ethics, economics, and social well-being.

Ehrenfeld, David. "Unethical Contexts for Ethical Questions," *Harper's Magazine, October, 2002*

MOOCs, online courses, & the future of education

- In these models, what are the implicit (or explicit) theories of learning?
  Are they consistent with research on learning?
  Compared to what?
- Roles of faculty, instructional developers, teachers, students

MOOCs, online courses, & the future of education

- In these models, what are the implicit (or explicit) views about the purposes and mechanisms of education?
- Providing access – of what sort, for whom?
- Who profits?

Technology in the classroom

A classroom is a community, learning is a social process. Technology should be designed and used to support this.

Clickers, video-based experiments, and online archives can extend and enrich the classroom, and support/structure interactions.

Technology in the classroom

Let pedagogical goals drive the use of technology.
Technology ≠ pedagogy. What you do is more important than the tools you use.
But tools can reorganize activities, roles, and norms.
Keep an eye on the broader context in which we work.

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