Physics 4810 / 7810 Week 12 (high noon)

Day 21: Fa2008:
Labs, Lab Skills and Scientific Reasoning

Eyes to web
Project DRAFT due next week
Then.. BREAK>>>>

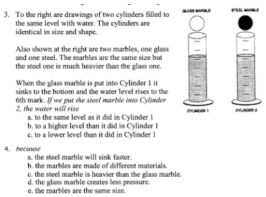
Outline of Discussion

- Clarifications
- A wee bit on Theory
- Goals of Labs
- Scaffolding / Supporting Students & Instructors in Labs
- Developing Scientific Skills
- Conclusion: the minimum energy state theorem

Clarification

- What is the Lawson Test?

I would not give the students such a handout. Give them a computer, and maybe a few books. This is how real problem solving is done after all


3. To the right are drawings of two cylinders filled to the same level with water. The cylinders are identical in size and shape.

Also shown at the right are two marbles, one glass and one steel. The marbles are the same size but the steel one is much heavier than the glass one.

When the glass marble is put into Cylinder 1 it sinks to the bottom and the water level rises to the 6th mark. *If we put the steel marble into Cylinder 2, the water will rise*
a. to the same level as it did in Cylinder 1
b. to a higher level than it did in Cylinder 1
c. to a lower level than it did in Cylinder 1

4. *because*
a. the steel marble will sink faster.
b. the marbles are made of different materials.
c. the steel marble is heavier than the glass marble.
d. the glass marble creates less pressure.
e. the marbles are the same size.

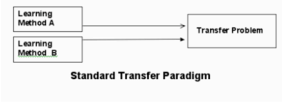
Clarification

- When you hold a variable as a covariate, what does that mean? Is that basically normalizing for how well students did on the Lawson's pre-test?
- Yes
- However, I'm not comfortable with p =0.001;
- Remember to think about **effect size** vs. stat significance… (think pedagogical significance)

Theory of Transfer

- Actor Network Theory
  - Not actors in theater but people in networks
- Coordination Classes
  - diSessa's work beyond p-prims (how we coordinate / assemble these into "concepts")
- Preparation for Future Learning
  - Different goal of assessment…

Preparation for Future Learning



Standard Transfer Paradigm

D. Schwartz AALab Stanford

?

Theory of Transfer

- What is definition of transfer?
- What does it say about nature of knowledge?
  knowledge moves from one domain to another
  assumes:
  (i) knowledge is a fixed thing to be moved;
  (ii) you know what to look for

Modifying notion of Transfer

- Lobato caveat:
  look for what moves rather than what hope / thought would move
- What if we don't think of knowledge as a fixed thing?
- What if we study the ability to engage in different environments? Recognize similarities?

What are we teaching in our labs?

- the design students are given the same type of activity they have already been given for 10 weeks
- I would expect the design group to design better labs than the non-design group since they spent the whole semester practicing!
- do we teach the students on how to take the exam?

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Goals of Labs ?

Goals of the laboratory

One can imagine a variety of goals for a laboratory:

- *Confirmation* — To demonstrate the correctness of theoretical results presented in lecture.
- *Mechanical skills* — To help students attain dexterity in handling apparatus.
- *Device experience* — To familiarize students with measurine tools.
- *Understanding Error* — To help students learn the tools of experiment as a method to convince others of your results: statistics, error analysis, and the ideas of accuracy and precision.
- *Concept building* — Help students understand fundamental physics concepts.
- *Empiricism* — To help students understand the empirical basis of science.
- *Exposure to research* — To help students get a feel for what scientific exploration and research are like.
- *Attitudes and expectations* — To help students build their understanding of the role of independent thought and coherence in scientific thinking.

Redish

Assumptions about labs

Hidden Hypothesis of Traditional Labs:

- learn content (maybe taught)
- ability to manipulate equipment (maybe taught)
- learn scientific reasoning skills (assumed to come along for ride)

identified assumptions and evaluated their effect on the result or validated them. It also shows that no non-design students did this. When would the non-design students have learned to do this? Were they ever instructed to identify assumptions in the traditional labs?

Parallels idea of conceptual understanding

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Skills Development

what skills are necessary/taught in:

- Traditional Lab
- Design Lab

??

what skills needed by:

- Scientific Researcher
- Technician

?

Supporting Development

- Consider various forms of "inquiry" or "design"
  i) Raw: here's a buck of water, dishsoap and a wisk
  ii) Challenge: make the tallest soap bubble tower possible. [possible reflection: where / why are the small and large bubbles located]
  iii) Recipe: step a - e
- What do students prefer? Why?

?

Challenges

- Student expectations / epistemology
  This type of lab class is the one I would say I would have freaked out over in my first year
- Faculty expectations / epistemology:
  I will say that running a design lab sounds much more difficult than a traditional lab.
  – What do faculty need to do differently?
  – What are additional things faculty need to know?

Habits of Mind

- What is going on during design labs

making; Writ.- writing; Proc.-Procedure; Rd. –reading
TA – TA help; OT – off task.

Design group							
	SM	Writ.	Proc.	Rd.	TA	OT	Tot.
Labs 1-10	37	66	24	5	18	8	159
s.d.	10	12	13	1.7	16.0	9.2	25.9
Non-design group							
Labs 1-10	14	41	20	4	17	2	96
s.d.	8.4	15.1	10.7	3.2	12.8	1.4	30.8

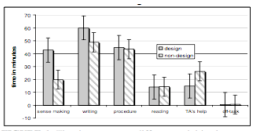

FIGURE 1. The time spent on different activities by teams of students during the final lab exam (biology task).

Low Energy Hypothesis

Students have an uncanny ability to find the low-energy state solution path to performing.

Corollary: if we could harness this we'd be stinking rich

Additional Corollary: if the low energy state solution is the path of learning, we all win.

Corollary Corollary: relevant, interesting, authentic practices usually link learning and performance.

Vote for next week

- Representation / Analogy

A true pie chart

- Preparation for Future Learning