Measuring the learning that matters (to you)

I. Identifying what learning/thinking that matters.

II. Measuring- in principle, and doing it with realistic limitations

Why are you here? What is the learning that you want to measure? Why did you choose that (why does it matter?)

Measuring learning--
Goal-- read mind. How much is thinking like expert?

Use proxies to measure
Give task
From performance on task, thinking like expert?

More explicit and detailed you can be about relevant expert thinking, more authentic the task, more accurate proxy of mind reading.

What are some ways task (like exam question) can go wrong? (bad proxy)

Frequently inauthentic tasks used in assessment--

• not measuring things expert ever needs to know

• alternative ways to come up with right answer (memorize without understanding the procedures that apply to specific situation, but only situations given on exam are precise match.)

•require some subtle trick, only know if guess idiosyncracies of intstructor ("figure out instructor, not figure out subject")

For authentic tasks, if was easier way to get right answer, experts would use it.

Setting Learning Goals: What Do You Want To Emphasize

- Knowledge and skills?
- Critical thinking, analytic reasoning and problem solving?
- Habits of mind and epistemology?
- Individual and social understandings of the roles and responsibilities?

from Rich Shavelson talk

What Does It Mean To Achieve In Science?

- *Declarative knowledge*: knowing that--facts and concepts in the domain
- *Procedural knowledge*: routine procedures and some aspects of problem solving
- *"Schematic" (analytic) knowledge*: conceptual models of how the natural world works
- *Strategic ("transfer") knowledge*: knowing when, where and how knowledge applies
- *"Epistemic" knowledge:* knowing how we know—knowing how scientific knowledge is built and justified
- *Communication & social skills*: ability to communicate ideas clearly and concisely in the genre of science, team work

from Rich Shavelson talk

Identify expert thinking/problem solving methods- "cognitive task analysis"

example-

"We want students to learn to be good field geologists."

Assessment? Send them out to work, see what employers say. Slow feedback.

Better--What do field geologists do?
Spend lots of time making geological maps of an area to be able to evaluate rocks there for various purposes.
Ah-- assessment-- send student out to make geo map of an area.

Useful information, but not that useful.

Just tells you if student is right or wrong.
Does not tell strengths and weaknesses, what to focus on to improve, $\Rightarrow$how to teach more effectively.

Also pretty challenging logistics, would like to get as much valid assessment information as one could in easier manner first.

better-- what are the cognitive tasks experts follow in making a geological map?

(example, then you will have to do this type of analysis for some task in your discipline)

Cognitive task analysis of doing geological field map

Plan for the field

1. Examine the topographic map and plan a path for your day.
2. Identify key areas that you plan to cover.
3. Recognize that knowing when to stick to your plan and when to diverge from it is a key skill in geologic mapping.

- Characterize rock outcrops as you follow your plan
  1. Identify minerals and rocks in the field at the outcrops you encounter, mapping them and taking careful notes as you go.
  2. Assess change from last outcrop (measure sufficiently to check), characterize change;
- Compare mapped outcrops
  1. Interpret data you have collected. How different is current outcrop from previous outcrop? If difference is large, spend time and take measures, revise INTERPRETATION of the outcrop.
  2. Identify structural trends/relationships in the data you have collected.
- Sense-making model (There is never just one geological model when mapping.)
  1. How well does the data match the model?
  2. How big is the extrapolation?
  3. Do the geologic contacts and structural relationships “make sense?”
- Predictive testing
  1. Identify other areas in the field area where the model can be tested
  2. Include these areas in plans for future field days.

Repeat these steps or go back and forth between them as needed.

Assessment-- break task down into the expert steps.

- Here are set of outcroppings, create model of the geological structure. Explain reasoning.
- Which are the regions where model is most uncertain? Why? How could you get data to improve?
- Here is a map. Here is a set of outcroppings observed. Is this map correct? Why or why not?

What if 200 students, 2 hours of TA time?

Here are set of outcroppings, which of the following 6 models/map images are consistent with them?
Which of the following 6 new models are inconsistent?
For this model, which of points A-H are most uncertain?

Back to 10 students, lots of TA time

- Here is topo map and what is known about geology in this region, draw route you would walk to collect data for map. Explain reasons for different segments of route.

200 students, 2 hrs TA time How would you do?

Suggestions?

Of the following 10 possible segments marked on map, which would be the 5 most important to walk?

For this segment, which of the 10 possible reasons would be relevant to why you would want to walk it?

For this segment, rank the 5 most important reasons for walking, in order of priority.

For this new segment, pick all the reasons that would make it less desirable a path to walk.

Physics or math problem solving example of task analysis?

- visualize problem and appropriate model (make sketch, label relevant physical quantities)
- what concepts apply
- what strategies useful or not, what procedures will work (what are similar or analogous problems?)
- plan solution steps
- convert model to mathematical representation (formulas)
- decide upon and carry out appropriate calculational procedures to get answer
- does answer make sense? (come up with criteria to use: units correct, limiting cases, symmetry, related cases where know answer)

assessment-- give solution up to that step, measure if student can complete next step in problem solving.
Same strategies as in geology example.

(Very helpful to test assessment. Give to a few students, have them do while thinking aloud.)

Are they solving using intended methods or strategies or finding "non-expert" shortcuts. If they are unsuccessful, is it because they are not using expert approach, or some other reason like not understanding wording of the question?

tip--If homework, use open ended short answer questions including asking for explanations, but only mark 1/3 of the problems.

Computer grading of expert thinking (makes it hard to just memorize without conceptual understanding and problem solving approaches:

"Of this list of 12 choices, select which information is relevant (or irrelevant to solve the problem)."

"What information do you need to solve this problem that is missing?"

"If X stops working as well as before, list which things might have changed that would explain this behaviour." (can also make quantitative if desire, not just what changed, but by how much)

"What changes would make x work better?" (faster, hotter, more radiation out, …)

Groups of 3, carry out cognitive task analysis. If get done, start thinking of ways to measure.

Remember not to leave out sense-making steps. Any missing step that can be a failure point will result in less meaningful assessment. If student fails, but you never assessed particular failure mode, you will not know they failed, if it was because of a step that is never measured.

look at a task analysis example or two from groups.
Find ways to measure a few parts.

Groups of 3, come up with analysis questions.

a) Open ended.

b) Computer graded.