Some Additional Thoughts on Intended Learning Outcomes

We have had some great discussions about ILOs. Some of you have expressed concern about the constraints on learning that specific, measurable and realistic ILOs may impose. Here are some examples that may help you see how specific, measurable and realistic ILOs do not necessary constrain learning.

Example 1

You might be teaching a class that has to prepare students for a downstream lab course that uses X-ray diffraction to identify unknown single crystal and powder diffraction samples.

In order to adequately prepare your students you will have to introduce them to the phenomena of diffraction, what is really happening when X-ray's interact with crystalline materials, how does Bragg' s Law capture this? What are the systematic absences in various structures, how does one index an unknown DP?...the corresponding intended learning outcomes (ILOs), the teaching and learning activities (TLAs) and the and aligned assessment tasks (ATs) are given below.

ILOs

- Explain the fundamentals of diffraction to an INE
- Apply Bragg's law to calculate d-spacing in single crystals
- Determine the Miller indices of an atomic plane corresponding to a given d-spacing
- State the rules for systematic absences in FCC, BCC and diamond cubic crystal structures
- Perform structure factor calculations to determine the diffraction intensities
- Accurately index an diffraction pattern from an unknown sample.

TLAs

- Students interact with a simulation of xray-solid interactions - wherein they can change the incident angle, and interplanar spacings
- Students solve pset problems that require them to use Bragg's law
- In small groups - students work on calculating the Miller indices of planes with given d-spacings. they then apply the rules for systematic absences to determine if their structures are FCC, BCC or diamond cubic.
- Students are introduced to the calculation of structure factor in class. For homework - students calculate structure factors for particular crystal structures, with given bases.

ATs

- ask students to describe how xrays interact with crystalline solids

- exam question: students are given an unknown material, and a set of measured d-spacings and incident asked to i.d. the crystal structure
- exam question: students are given a schematic of a crystal structure - and asked to calculate expected intensities (not that this can be much more complex than the example done for homework)
- Note that the pset questions are both ATs AND TLAs

If you have clearly stated the ILO that students should be able to index an unknown diffraction pattern, AND you have given your students practice (on psets and in class work) on the indexing of an unknown pattern...it would be perfectly reasonable and fair to ask them to do this on an exam...you could lay out completely different systematic absence rules if you wanted, or use a structure with a complex set of bases...what you ask them to do on an exam can be much more complex and/or challenging (i.e., you are not "teaching to the test") - but it should not be completely new to them. With respect to a particular topic or concept, if you have only previously asked them (in class and on psets) to "remember" or "recall" (a la Bloom's taxonomy) - it's not really fair to ask them to "evaluate" or "create" something (related to that topic) on an exam.

This is not watering down the material - it is telling students what is important - and finding an authentic way to measure whether or not they "get it". You have plenty of room to ask challenging and complex questions on exams and projects.

I have one other, more extreme example that may help make my point:
If you were teaching someone how to fly a small airplane you would not think it was o.k. to teach them how to take off, and to fly the plane, but on their final exam, or pilot's license test ask them to *also* land the plane. In order to determine if they should really be allowed to fly a plane without supervision, you would certainly want to teach them, and give them practice in taking off, flying *and* landing a plane - but on the exam - you might turn off certain controls or gauges, or simulate limited visibility or weather conditions. Just because you *told* them that they would be required to take-off, fly and land a plane, doesn't mean that you have watered down the instruction or the expectations/requirements.

5.95J Teaching College-Level Science and Engineering
Fall 2015