What Ideas Should We Be Teaching, and How Can We Assess Whether Students Have Learned Them

Presented by Melanie Cooper, Ph.D.
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1425 Biomedical Physical Sciences Building

Abstract: There is a saying: "*If you don't assess what's important, what's assessed* **becomes** *important*." What we assess in our courses sends a not so implicit message to our students about what they know and be able to do. If we only assess recall of facts and rote problem solving, then that is what students will learn – even if we have more profound goals in mind. In this workshop participants will use evidence-based approaches to developing assessments that incorporate both the "big ideas" of a particular discipline and the practices of science and engineering (for example using models to explain and predict, and constructing explanations). That is we will develop assessments that ask students to use their knowledge – rather than regurgitate it. We will also consider what evidence we would accept that a student "understands" and use this evidence to develop rubrics that can both be used to grade and to construct more informative assessments.

Biography: Melanie Cooper is the Lappan-Phillips Professor of Science Education and Professor of Chemistry at Michigan State University. She received her B.S., M.S., and Ph.D. in chemistry from the University of Manchester, England. Her research has focused on improving teaching and learning in large enrollment general and organic chemistry courses at the college level, and she is a proponent of evidence-based curriculum reform for example the NSF supported "Chemistry, Life, the Universe and Everything." She has also developed technological approaches to formative assessment that can recognize and respond to students free-form drawings such as the *beSocratic* system. She is a Fellow of the American Chemical Society and the American Association for the Advancement of Science, a member of the Leadership team for the Next Generation Science Standards (NGSS), and the National Research Council Advisory Board on Science Education (BOSE). She has received a number of awards including the ACS award for research on teaching and learning 2014, the Norris Award for Outstanding Achievement in teaching of chemistry in 2013, and the 2010-2011 Outstanding Undergraduate Science Teacher Award from the Society for College Science Teaching.

Video: https://vimeo.com/108895602

Notes

- Active engagement improves learning
    - Freeman 2014 PNAS
- In the lower level courses, the "book" often becomes the curriculum
    - Most textbooks have not been assembled based on the principles upon which/how people learn

- Be careful with your learning objectives
  - Don't use words like "understand" or "be able to" in your test questions
    - Not helpful and not connected at all to students
    - Experts do not have fragmented concepts about the certain topics – students do not have these expert capabilities in a class
- Disciplinary core idea
  - Disciplinary significance
  - Explanatory power (students should produce explanations, observations, and predictions!)
  - Generative, content knowledge is not enough
- Core ideas for our discipline (*i.e.*, science)
  - Biology = evolution, the scientific method, unity of life, species diversity, the nature of science
- Scientific and engineering practices
  - Put knowledge to use
    - Asking questions/defining problems
    - Developing and using models
    - Planning out and carrying out investigations and design solutions
    - Analyzing and interpreting data
    - Using mathematical and computational thinking
    - Developing explanations and designing solutions
    - Engaging in argument from evidence
    - Obtaining, evaluating, and communicating information
- An argument has three parts
  - Claim – the target of the explanation
  - Evidence – the scientific principle/data
  - Reasoning – the link between the two
- To understand a phenomenon is to understand hot it is caused (Stevens M. 2013)
- Explanation is the "phenomenological mark of an evolutionary determined drive" (Allison)
- Science practices are assessable
  - Compare learning objectives and learning performances
  - How else do we know when the students learn? Assessment
    - Assessments should improve, not audit
    - 3D learning can guide assessments
    - Evidence centered design
    - What is accepted as evidence of 3D learning?
      - Emphasize 3D learning
- Ask deep, explanatory questions
- Cross-cutting concepts (NRC)