Assessment and Learning

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Organization of the Short Course

- Agenda
- Logistics
- Wiki

Setting the Stage

Recommendations from national reports on the state of STEM education in higher education institutions.

- Development of new content and curriculum
- Implementation of more effective pedagogy and assessment
- Focus on student skills as important learning outcomes
- Improving of scientific literacy in citizens, and
- The potential of information technology (IT) to support learning

http://naples.cc.sunysb.edu/Pres/boyer.nsf/

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Higher Education Reform Requires

University teaching is one of the few social activities that has not fundamentally changed.

Reform requires

- Infrastructure & tools
- New teaching practices focused on learning
- Removal of barriers that limit faculty participation in the reform effort

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Calls to Engage Scientists & Engineers

- Efforts to reform secondary and tertiary science education often call for scientists' participation
- Supported by major funding agencies: NSF, NIH, HHMI
- Most models describe roles for scientists that
  - Have limited systemic impact
  - Rarely create synergy between the science research and education

nature

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Educating future scientists

Instead of helplessly pondering a new trove of data for guidance on how to improve science education, researchers should better exploit existing mechanisms for helping out at their local schools.

A quarter of a million 15-year-olds from around the world last year performed hours of special tests on their reading, mathematical and scientific literacy, in a study organized by the Organisation for Economic Co-operation and Development (OECD). The first results of this Programme for International Student Assessment (PISA) have just been released — and make moderately interesting reading.

Korea sits at the top of the science class, closely followed by Japan, Finland and the United Kingdom. Given its wealth, the United States (which has the widest gap between its best and worst students) should certainly do better than its mid-table position. Germany, surprisingly, performs the least impressively of the major scientific nations, with results below the overall international average. The science results closely mirror those in reading and mathematics, and it might be tempting to draw instant conclusions from them: some in Germany have already done so. But caution is appropriate in interpreting such studies, which really provide more questions than answers for policy-makers.

The most noted recent international comparison of school performance was the Third International Mathematics and Science Study (TIMMS), which was completed in 1999. But the questions in TIMMS sought, in the main, to measure students' grasp of the facts contained in school curricula. PISA, in contrast, sought to measure their ability to apply knowledge.

This attempt to measure the evaluation and interpretation skills of children should be welcomed. But it would be a mistake to assume that the scientific futures of countries at the summit of this particular PISA tower are necessarily going to be rosier than those of nations that fared less well. Just because a student is good at a subject, there is no guarantee that he or she will continue to study it. As generations of teachers will confirm, there is often little correlation between academic ability, which the study sought to measure, and enthusiasm.

Indeed, many of those directly involved in school education speak of an increasing reluctance among students to continue studying science once it ceases to be a compulsory subject. The reasons for this have been well rehearsed. Science faces stiffer competition from other subject areas than previously, both in the struggle for attention and in the promise it offers of assisting a successful career. It is also relatively content-heavy — however it is packaged — and even the most skilful teacher may struggle to make some of its more esoteric aspects relevant to the world of the average 13-year-old.

The scientific community has a stake in these problems, but it is one tinged with paradox. A more accessible — and perhaps less challenging — curriculum might well encourage wider participation and a larger pool of students willing to continue studying science. But such a curriculum will not best help the very brightest students whose interest in science might lead them into a career in it. The argument about which direction to push the curriculum will doubtless continue. As it does so, scientists can do more than grumble from the sidelines about declining standards.

Many scientific organizations already take a strong interest in science education in schools. The US National Science Foundation — whose charter includes supports for education as well as research — now asks all grant applicants to explain what their research proposal will do for education, and this can include school education. In Britain, a programme called the Pupil Researcher Initiative, funded by the research councils, offers school students the chance to regularly hear from active researchers. A wealth of other such schemes operate around the world. Now is the time for researchers — some of whom are reluctant even to engage properly in undergraduate education — to seek these out and participate in them. ■

Europe must unite to preserve its heritage

The European Commission should not lose its enthusiasm for supporting research into the preservation of cultural heritage.

Relatively speaking, it's a discipline that doesn't cost much — and its value is beyond measure. Yet research into the conservation of Europe's vast cultural heritage has few real champions. Its best friend is Italy, the only country in the European Union (EU) that provides serious national funding for research into the preservation of monuments, ancient ruins and archaeological sites.

But even Italians concede that the Leaning Tower of Pisa, for example, is no more representative of Europe's heritage than, say, the historic centre of a village in Norway. Conservation efforts should be truly European in scope, not only to acknowledge Europe's cultural unity — which is supposedly central to the EU charter — but for technical reasons, too. It is widely accepted, for example, that the standardization of procedures for building preservation will save money and help to efficiently share out the limited pool of available expertise.

For 15 years, the European Commission has shown itself sensitive to these issues. Its approach recognized the fact that national efforts outside Italy tend to be narrowly focused and piecemeal. Unfortunately, however, the commission's proposal for the next Framework research programme, which starts in 2003, makes no mention of the conservation of cultural heritage. National governments, it implies, should handle the problem themselves. This attitude is short-sighted.

The list of research needed for heritage conservation is long, and underlines the need for continued support from the EU. Thresholds for air quality should be set, for example, with building conservation goals in mind. Research is badly needed into the interactions between ancient building materials and the modern alternatives used in restoration. Movement of the water table, which is affected by global warming and controls the destiny of buried archaeological ruins, needs to be better understood. Italy knows it cannot afford to let Venice float away to sea, but the rest of Europe needs to ensure that other aspects of its valuable heritage are preserved for future generations. ■

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Nature, 13 December 2001

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Dissatisfaction Leading to Change

"When I started as a teacher, my students, my administrators thought that I was doing a very admirable job. And as long as I asked questions I had trained the students to do, they did fine. But if I snuck up on them just slightly and went for some depth of understanding, then they were in trouble. And that bothered me."

Minstrell, J. (1997) In Annenberg/CPB Minds of Our Own Videotape. Program One: Can We Believe Our Eyes, Math, and Science Collection. Burlington, VT.

Teaching in the Fiji Islands as a Peace Corps Volunteer

Tenure Opened New Avenues for My Professional Career

What should be the nature of the education-research continuum in academic life?

- AGI-IDIG, University of South Carolina, Columbia, SC (1998)
- NSF/AGI Earth Science Education Working Group, Colorado School of Mines, Golden, CO (1998)
- Member, NSF DUE CCLI Review Panel (1999)
- TAMU Tenure & Promotion Committee (circa 2001)

Number One Quote from the 1998 IDIG
"No, it is even more insidious than that...."

First Activity:
Why are you here?

Group discussion

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Overview of Assessment

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Assessment of Learning

"Assessment is the ongoing process of establishing

- clear, measurable expected outcomes of student learning,
- ensuring that students have sufficient opportunities to achieve those outcomes,
- systematically gathering, analyzing, and interpreting evidence to determine how well students learning matches the expectations and
- using the resulting information to understand and IMPROVE student learning."

Suskie, L. (2009) *Assessing student learning: A common sense guide*. San Francisco: Jossey-Bass.

Choosing Assessment Methods

- What is purpose of assessment?
  - Formative
  - Summative
- Does assessment align with learning goals?
- How will assessment show:
  - What students have learned?
  - That students have progressed?
- Will multiple assessment forms be used?

Steps in Assessment Design

- Clearly state purpose for assessment:
  - Content goals (whether & how much)
  - Process goals (diagnose, plan)
- Define what to assess:
  - Cognitive skills
  - Social & affective skills
  - Metacognitive skills – reflect, evaluate
  - Problems solving skills
  - Concepts & principles to be able to apply
  - Knowledge transfer
- Match assessment method to achievement purpose above

Steps in Assessment Design

- Match tasks to intended learning outcomes
  - Outcomes to be measured
  - Assessment administration process
  - Actual question(s)/problem/prompt
  - Scoring
- Specify criteria for judging student performance
- Develop reliable rating process, train raters
- Use test results to refine assessments

NCREL. nd. Select or design assessments that elicit established outcomes. http://www.ncrel.org/sdrs/areas/issues/methods/assment/as7sele2.htm

Assessment of Learning

Educational assessment rests on three pillars:

- model of how students represent knowledge and develop competence in the subject domain
- tasks or situations that allow one to observe students' performance
- interpretation method for drawing inferences from the performance evidence

(Pellegrino et al., 2001)

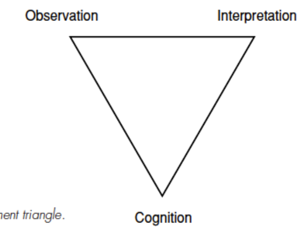


FIGURE 2-1 *The assessment triangle.*

3 Ps: Understanding the Nature of Learning

Psychology - Learning

Cognitive Science, Information-processing, Social psychology, Activity theory

Philosophy - Knowledge

Epistemology; Science Studies; Models, Argumentation; (*ETHICS)*

Pedagogy – Teaching Practice

Inquiry Learning; Problem-based Learning; Community of Learners; Model-based Learning; Design Principles, Preparation for Future Learning

History of Thinking about Human Mind

- Differential Perspective
  - Individual, Mental Tests separate from academic learning - selecting and sorting
- Behavioral Perspective
  - Stimulus/Response Associations - rewarding and punishing
- Cognitive Perspective
  - Prior Knowledge, expert/novice, metacognition (thinking about thinking and knowning)
- Situative Perspective
  - Sociocultural, language, tools, discourse

Psychology & Education

Structured Knowledge
Prior Knowledge
Metacognition
Procedural Knowledge in Meaningful Contexts
Social participation and cognition
Holistic Situation for Learning:
Make Thinking Overt
(Glaser, 1994)

Types of Knowledge

- Declarative (what);
- Procedural (how);
- Schematic (why);
- Strategic (where, when)
- Conceptual, Epistemic, Communicative or Social
- Bloom's Taxonomy
  - Knowledge, comprehension, application, analysis, synthesis, evaluation

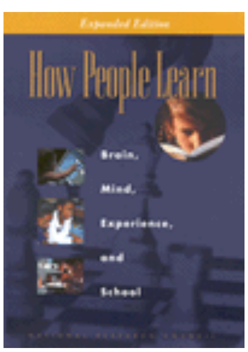
Nature of Science

- Science is about testing hypotheses and reasoning deductively from experiments
  - Hypothetico/Deductive Science
- Science is Theory building and revision
  - Contexts of Generation and Justification
- Science is Model building and revision
  - Models stand between Experiment and Theory

Performances - Practices

- Piano
  - Finger/hand strength and flexibility
  - Read muscial notation
  - Musical phrasing, playing with feeling
  - Creative musicality
- Science
  - Building conceptual claims, meanings
  - Evaluating conceptual claims, meaning
  - Seeking evidence
  - Seeking explanations
  - Communicating

Nature of Learning



How People Learn: Brain, Mind, Experience, and School: Expanded Edition

http://fermat.nap.edu/catalog/9853.html

- Humans are goal-directed agents who actively seek and use information.
- Prior knowledge, misconceptions, skills, beliefs and concepts significantly influence what humans notice about the environment, how they organize knowledge and use knowledge.
- Competence in an area of inquiry requires a deep foundation of factual knowledge, an understanding of facts and ideas within the context of a conceptual framework, and an organization of knowledge that guides retrieval and application.
- People can take control of their learning through active learning that is guided by metacognitive strategies and social interaction.

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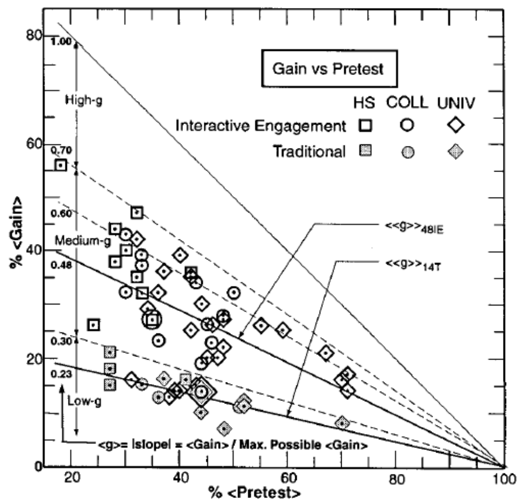
Linking Assessment to Teaching Practice

Impact of "Interactive Engagement" in Physics

Percent learning gains on standardized pre- and post-tests in physics for 62 courses enrolling N=6542 students in high school, colleges and universities



Hake, 1998, Am. Assoc. Physics Teachers, 66(1): 64

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Program

Evaluation

The Evidence Based Decision Making Cycle

Adapted from Peggy Maki, Ph.D. by Marilee J. Bresciani, Ph.D.

Activity:

Seeking Change

Group discussion: What would you like to change?