High School Science Laboratories: State of the States

Presentation to The National Academies Board on Science Education High School Labs Study Committee Second Fact Finding Meeting

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Background: Arthur Halbrook's Work with the Council of Chief State School Officers (CCSSO)

1. Coordinate seven (7) state consortium that has already developed an assessment bank of 1300 science items, created a website to house the items, and is presently beginning a new item development phase
2. Coordinate 16 state consortium on Technical Issues in Large-Scale Assessment
3. Co-Direct 16 state consortium on Comprehensive Assessment Systems
4. Liaison to Council of State Science Supervisors (CS3)
5. Liaison to National Science Teachers Association (NSTA)
6. Editor of the ***Summary of Annual Survey of State Student Assessment Programs***
7. Liaison to US Dept of Ed
8. Liaison to Networking for Leadership, Inquiry and Systemic Thinking (NLIST), a joint project of CS3 and NASA

STATUS UPDATE

I. General Overview of State Progress in Answering to NCLB Mandates
   A. Varying Stages of Science Assessment Implementation, Using the Purchase of a Vehicle as an Analogy
      1. Owning a car and traveling to a predetermined destination via a planned route
      2. Taking a car for a test drive and seeing firsthand how the model works
      3. Looking at a car that you might purchase and actually getting inside
      4. Gazing at a car through the showroom windows
      5. Looking at a car in a magazine
      6. Falling asleep on the couch as a car commercial appears
      7. Denying the existence of cars, believing that skates work fine, and hoping all the furor will go away

   B. What Is Known about Science Laboratories
      Very little research exists on the state of science laboratories or the impact they are having on science assessment. CCSSO engages in an enormous number of surveys and the data received cover a large spectrum of education. However, no

one has yet requested a study of the laboratories specifically. Obviously, the need exists.

In lieu of data, I spoke with a number of teachers and science coordinators about laboratory use. Many laboratories are fully stocked, but teachers lack the training.

Utility of Labs

1. Face validity
   a. Political
      Political capital—the school has X number of computers and X number of science laboratories. This sends an enormous message about what the school and school system values most.

   b. Instructional
      Having a lab in a science or physics classroom is akin to having a dictionary in an English language arts classroom. They are expected to be there whether they are used or not.

2. Enhancement (to move beyond the text)
   To enhance instruction and allow for hands-on scientific inquiry

3. Integral part of the curriculum
   The science classroom and the science lab act as a single entity. There is a seamless transition between laboratory and desk experience.

4. Meeting state/national standards

II. Key Questions to Address

A. What are the challenges in assessing students' learning from laboratory experiences?

>>>>The greater challenge might be to create laboratory experiences that matter, that go beyond measuring how many milliliters are in the beaker.

B. How do state education standards and accountability systems (particularly state assessments) enable or constrain effective learning and teaching in high school labs?

The assessment of laboratory activities on a large scale is not easily accomplished and obviously major challenges exist:

COST = Are there sufficient funds for laboratory equipment, for creating the assessment, for scoring the assessment, for disseminating the results, for professional development involving students, teachers, and the public?

ACCESS = How many schools have laboratories that are large enough and equipped with sufficient apparatus to provide laboratory instruction on a consistent basis?

How many schools have laboratories that can accommodate students with special needs?

STAFFING = How many teachers are sufficiently trained to work in the laboratory and guide students?

VALIDITY/ RELIABILITY = Have all students had the same instruction on the same type of equipment under similar circumstance or has differential instruction occurred? In other words, how level is the playing field?

LEGALITY = If instruction varies, if the laboratories vary, if the time in the laboratories varies, can students be held accountable on an assessment for which these variables are not controlled?

INVOLVEMENT = At what level are students involved
(1) Reading about the experiment
(2) Seeing the experiment or viewing the experiment
(3) Performing the experiment

SECURITY = How can an assessment be administered without others observing and essentially seeing how to perform the experiment or use the equipment?

Laboratory Assessment

1. Forms of assessment
   a. Multiple-choice
   b. Short constructed response (rubric required)
   c. Extended constructed response (rubric required)
   d. Performance event (rubric required, most expensive)

2. Scoring the assessment
   a. Computer
   b. Trained evaluators (using rubric)
   c. Hybrid model (using rubric and computer)

3. Delivery formats
   a. Laboratory work in laboratory setting (independently)
   b. Laboratory work on a small scale with limited scientific apparatus (independently in cubicle or at desk)
   c. Viewing a laboratory experiment being performed either through a video or live presentation that would permit the student to evaluate what has happened or what will happen (independently)
   d. Computer simulations (without video)
   e. Computer adaptive
   f. Computer delivered
   g. Small group of students working cooperatively
   h. Pencil and paper copy with fill in the bubble

4. In Practice

   Pilot studies involving laboratory assessments are being conducted in many school districts, especially affluent ones. However, large-scale assessments are not as pervasive.

5. Cost/Time Perspectives
   a. Producing a useable item can cost from $250 to $500 per assessment item
   b. The cost of scoring using individuals to hand score an item is approximately 6000x more expensive than scoring via an automated scoring system
   c. Producing a final test form generally takes from three (3) to five (5) years. Compressing this timeline can prove extremely stressful for both test developers and state assessment staff.

C. To what extent and how can classroom level assessment of skills and knowledge developed through laboratory experiences be linked to large-scale science assessment used by districts or states?

D. To what extent and how can large-scale assessments used by districts or states be designed and implemented in ways that are sensitive to (or capture) the learning that occurs through laboratory experiences?

While there are no silver bullets, much can be done to enhance present educational structures:

1. Widespread pilot programs that use the laboratory on a consistent basis and which test laboratory use
2. Consistent teacher training on laboratory experiences

3. Questions that focus on inquiry based science
4. Clinical work in the laboratory that uses skills that can be applied to other work, both inside and outside of the science lab
5. Consortium building, with everyone supporting laboratory assessments as an integral part of the overall assessment program. This consortium could take several forms. One could come in the form of state consortiums as seen in the State Collaborative on Assessment and Student Standards used by the Council of Chief State School Officers (see the SCASS Science project at www.ccsso.org). Or, on smaller levels, the consortium might involve districts or schools.

Ultimately, the goal is to produce an effective assessment involving laboratory experiences that is robust, cost effective, valid and reliable, and tests important concepts that are aligned to state and national standards. The goal is a noble one but as Kozol noted so poignantly in another context, for many states "the night is dark and we are far from home."

FINAL OBSERVATIONS:

1. As noted earlier, the degree to which states are undergoing item development in science varies. Moreover, there exists few large item banks within states.
2. Assessing science is a highly sophisticated undertaking and perhaps more demanding than the other disciplines in terms of creating robust items.
3. Because of monetary constraints, lack of staff, and no AYP demands being made, states will expend more of their assessment efforts on language arts and mathematics. As a result, when action is finally taken to create science assessments, many states will opt for vendor produced items and off-the-shelf assessments.
4. Science laboratory assessment will remain the underling of assessment until there is a national effort that focuses on laboratory use as inseparable from other classroom activities. Using science laboratories must be seen as essential in the learning process and this view must be reinforced by decision makers at all levels. This includes the chief state school officers, the deputies, the state board of education, the curriculum coordinators, the assessment coordinators, the supervisors, the teachers, the students, the parents and guardians, and the general public. This reinforcement also extends to the legislators who fund the efforts and to other policy makers involved with educational efforts.
5. A national survey is needed to examine what is happening in science laboratories, a survey that goes beyond anecdotal evidence of events. Rolf Blank rolfb@ccsso.org at CCSSO has conducted a number of surveys through his Surveys of Enacted Curriculum (SEC)Project—the most recent ones focusing on math, science, and English language arts. However, the need is to go much further, broaden the scope, and involve as many states as possible in the data collection.

6. Educators must reach some form of consensus on what laboratory experiences should be, what is important to assess, and why such experiences are essential. Having data to support their views is crucial.

If you have questions or need additional information, I may be reached at the following:

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