Commentary

Assessment as a Tool for Improving Science Teaching and Learning

By George E. DeBoer, PhD

From high school exit exams to classroom quizzes, student assessment continues to play an increasingly important role in U.S. education. In the era of No Child Left Behind—the most recent reincarnation of the Elementary and Secondary Education Act of 1965—the focus has been primarily on large-scale assessment systems designed for accountability, rather than the potential to improve teaching and learning. With the pending reauthorization of that legislation, the Obama Administration has laid out a plan that could take assessment in a much more promising direction, one calling for assessments that are "valid, support and inform instruction, provide accurate information about what students know and can do, and measure student achievement against standards." And given the growing use of student performance on high-stakes tests to measure teacher effectiveness, it is all the more important that the purpose of these tests shift so they can provide the detailed feedback teachers need to modify their teaching and improve student learning.

The American Association for the Advancement of Science's Project 2061 recently completed a seven-year science assessment development project with funding from the National Science Foundation. Our research team worked with hundreds of science educators and researchers and involved thousands of students in classrooms across the country to develop a collection of test items designed to find out precisely what students know in science and the misconceptions they have (*http://assessment.aaas.org*). Based on this work, here are some lessons to consider as teachers, researchers, and policy makers develop both large-scale and classroom assessment programs to improve teaching and learning.

- **Effective assessment begins with clear statements of what students are expected to know.** The foundation upon which all science assessment is built is the clear statements of the knowledge and skills we expect students to have. The anticipated new conceptual framework to be released by the National Research Council and the plan to develop the next generation of standards based on that framework continue a tradition of specifying what students should know in science. The framework will provide broad-based guidance about what the science curriculum should include, and the content standards will provide the details. Depending on the level of specificity of these content standards, the assessments we are calling for may require additional clarification. In our work, we wrote clusters of sub-ideas for each "big idea," which taken together tell a coherent and integrated story about the science we expect students to know and add further precision to the assessment items we developed.
- **Alignment means more than matching test items to topics or keywords.** Just as it is essential to have clear and precise statements of learning goals as the foundation for assessment, it is also important that assessment items do in fact align to those learning goals. Often alignments are made at the broad topic level (animal biology) or perhaps, at a more specific content level (circulation, digestion, respiration). Testing students on questions about the circulatory system may be useful as part of a broad accountability model, but it is of little use if the results are to be used to improve teaching and learning. Instead, assessments need to test the specific knowledge in the target learning goals so teachers can determine exactly what students know and do not know.
- **Identifying students' misconceptions and alternative ideas can be a powerful tool for teachers and curriculum developers.** Another way to pinpoint students' ideas is to focus on their misconceptions. Documented misconceptions can be used as answer choices in multiple-choice questions (which is the approach we used), or they can be built into the scoring rubrics of open-response questions. In our work, we found misconceptions that persist through high school and even into college. It is critical that these misconceptions be identified as soon as possible so they do not create obstacles to more advanced learning later on. With more information on the alternative ideas students have, along with what they know and do not know, teachers can design instruction to help students make progress in their understanding of science.

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Given the scale and cost of creating, administering, and taking tests—at the state, district, and classroom levels—enormous potential exists for them to be used to improve teaching and learning. Some have argued that assessment systems need to be broadened to include a wider variety of high- and low-stakes tests, but such a change on its own will not improve teaching and learning. This is not a call to broaden the scope of assessments, but a call to sharpen assessments so they can become more powerful educational tools. It is not enough to say 40% of the students in a particular state are proficient in science. That information is of little use unless it also tells us exactly what students know, what they do not know, and the misconceptions they have. Failure to make the adjustments needed to accomplish this is wasteful and unnecessary. ●

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