Guest Editorial

The Changing Landscape of Assessment

By Richard A. Duschl

"The times they are a changin'" Bob Dylan wrote in the 1960s. How very appropriate is that sentiment today in science education. The National Research Council (NRC) summary reports *Taking Science to School* (2007) and *Ready, Set Science!* (2008) informed us that we have underestimated the science abilities of K–8 children. Children, even before kindergarten, are more capable than we ever thought—capable when accessible contexts are used and the classroom environment is geared toward the critique and communication of ideas and information. Surely, we have all noticed how a child's motivation, interest, and abilities can shift from one science topic to another. Our images of children need changing.

STEM policy reports like *The Opportunity Equation* (see Internet Resources) inform us of the need to align curricula, instruction, and assessments and to do so around core standards that are fewer, higher, and coherent. Our guidelines for selecting and sequencing what to teach within and across grades need changing.

Late June is the anticipated release date for NRC's *A Framework for Science Education* (see Internet Resources) organized around the coordination of three domains: Core Ideas, Cross-Cutting Concepts, and Science Practices. The *Framework* will form the core of the *New Generation Science Standards.* These new science standards will join the existing Core Standards in English and Mathematics adopted by the majority of states. An additional charge is that the standards be linked to learning performances. How we assess, what we assess, and when we assess need changing.

Assessing and evaluating science learning and the progression of learning is complex. Learning to do so effectively will require collaborations with classroom teachers and science educators like you. It is a complex problem. Sound classroom level assessments by teachers are what keep learning on track. New technologies (cell phones, handhelds) and new tools (diagnostic assessment systems) provide teachers with information to guide learning and adapt instruction. Research has long informed us that the best learning environments—be they classrooms, homes, museums, or daycare centers—monitor and mediate learning. Giving quality feedback on meaning-making and reasoning is what makes a great teacher. The research is telling us that teacher practices in regard to what is assessed and how it is assessed need changing.

In science, one important domain is assessing inquiry—monitoring and giving feedback on the knowledge meaning-making and the investigative and cognitive science practices that comprise the essence of science (namely, using evidence for building and refining explanations, models, and mechanisms). Although science involves doing investigations to obtain evidence, science is so much more. Our images of inquiry frameworks need changing.

Learning science, as we well know, is not simply learning facts and knowledge claims. Learning science is using facts and claims to pose, build, and refine explanatory models and mechanisms. As such, assessing inquiry is the keystone to good science instruction. I (along with others) have interpreted the essential features of inquiry (NRC 2000) as containing three transformations in scientific inquiry (Duschl 2003):

- Data to evidence, or determining whether data are anomalous or count as valid evidence;
- Evidence to patterns, or searching for patterns in and generating models for evidence/data; and
- Patterns to explanations, or developing explanations on the basis of the evidence/models selected.

Assessment of inquiry should focus on students making these transformations. Unpacking these transformations brings us to the central role of scientific practices. What the inquiry transformations signal is the need to make evidence problematic for students. Not something given but rather something that is obtained, evaluated, wrestled with, argued over, applied, represented, and communicated. What we want for children at all grade levels is to experiment for reasons and to reason about experiments. Our images of doing science need to change.

Taking Science to School (NRC 2007) tells us we need to move from science processes to science practices. Curriculum materials and instructional methods need to change from thinking about teaching general inquiry processes to thinking about teaching and having students engage in specific science practices. This is what the 4 Strands of Science Proficiency in *Ready, Set, Science!* (NRC 2008) are all about:

- Strand 1: *Understanding Scientific Explanations*—e.g., understand central concepts and use them to build and critique scientific arguments;
- Strand 2: *Generating Scientific Evidence*—e.g., generating and evaluating evidence as part of building and refining models and explanations of the natural world;
- Strand 3: *Reflecting on Scientific Knowledge*—e.g., understanding that doing science entails searching for core explanations and the connections between them; and
- Strand 4: *Participating Productively in Science*—e.g., understand the appropriate norms presenting scientific arguments and evidence and to practice productive social interactions with peers around classroom science investigations.

So what does research tell us inquiry sounds like?

- *Planning investigations for data* is children deciding the selection of questions, tools, and schedules for observation, tools, and units for measurement.
- *Data collection to evidence* is children observing systematically, measuring accurately, structuring data, and setting standards for quality control.
- *Evidence to searching for patterns and building models* is children constructing and defending arguments, presenting evidence, engaging in mathematical modeling, and using physical and computational tools.
- *Patterns and models to generate explanations* is the sound of children posing theories, building and reporting conceptual-based models, considering alternatives, and generating new productive questions.

Fundamentally assessing inquiry is all about making thinking visible through "Talk and Argument" and through "Modeling and Representation," Chapters 5 and 6, respectively in *Ready, Set, Science!* (NRC 2008). Assessing science inquiry begins with teachers and students learning how to listen for and respond to the core science practices involved with the critique and communication of science claims. The set of research and policy reports are strong evidence that we as teachers, science educators, and science education researchers have learned how to learn about learning. The answer isn't just "blowin' in the wind," now we have evidence!

Richard A. Duschl (rad19@psu.edu) *is the Kenneth B. Waterbury Chaired Professor in Secondary Education in the Curriculum and Instruction Department at Penn State University in University Park, Pennsylvania.*

References

Duschl, R.A. 2003. Assessment of Inquiry. In *Everyday Assessment in the Science Classroom,* eds J.M. Atkin and J. Coffey (pp. 41–59). Arlington, VA: NSTA Press.

National Research Council (NRC). 2000. *Inquiry and the national science education standards: A guide for teaching and learning.* Washington, DC: National Academies Press.

NRC. 2007. *Taking science to school! Learning and teaching science in grades K–8*. Washington, DC: National Academies Press.

NRC. 2008. *Ready, set, science!: Putting research to work in K–8 science classrooms.* Washington, DC: National Academies Press.

Internet Resources

The Opportunity Equation
http://opportunityequation.org

Conceptual Framework for New Science Education Standards
www7.nationalacademies.org/bose/Standards_Framework_Homepage.html