Guest Editorial

Hard to Teach Does Not Mean Impossible

By Susan Koba

Science deserves attention as early as possible in elementary schools, and young children are capable of learning much more than previously thought (Duschl, Schweingruber, and Shouse 2007). *A Framework for K–12 Science Education* and the emerging Next Generation Science Standards hold high expectations for children (NRC 2011). Teachers want students to reach these expectations, but some concepts are harder to learn than others. Even with repeated instruction, some student preconceptions persist. Yet teachers must promote understanding and provide the foundation for future science learning. Luckily, these challenges are surmountable! What are possible ways to tackle these difficulties?

Establish a Safe Learning Environment

To promote conceptual change it is essential to know what children think. This partially depends on a learning environment in which students feel safe to express their explanations of observed phenomena. Children must feel comfortable in order to take risks but might be used to teachers who too often expect the "correct" answer.

Science concepts continually evolve as we learn more about the world around us. Actively engaging students in science helps them understand scientific explanations, reflects the way science is done, and is preferable to judging students' answers as "right" and "wrong." A shift in teacher language helps express this focus. "What evidence do you have that makes you think that?" and "Why do you agree with Manuel's explanation?" are options to "That's correct, Lily." Use language that focuses on best explanations, why students deem them the best, and evidence they have that supports the explanation. Provide opportunities to test their explanations; evidence gathered from experiments might encourage them to modify explanations. They can then compare their explanations to scientific explanations in text or online.

Focus on Student Thinking

Research about common student preconceptions is available for a variety of science topics. Explore what research says about student thinking and preassess students' conceptions, perhaps through a writing prompt. Plan learning experiences that target on these conceptions and ways to change them (see Internet Resources).

There are many instructional strategies that elicit children's explanations of observed phenomena, making their thinking evident to themselves, their teacher, and their peers. Teachers can make student thinking more explicit by selecting a variety of strategies, both linguistic (reading, writing, speaking, and listening) and nonlinguistic (models, visual tools like webs and organizers, drawing, and kinesthetic activities; see Internet Resources). A teacher might use a web analogy to better understand the interdependence of organisms, a dynamic model to learn about the phases of the Moon (animation makes this more concrete), or a three-dimensional model to show Earth's tilt each season to help visualize how tilt affects the amount of direct light that reaches each hemisphere.

Intentionally teach to keep student thinking at the surface and modify instruction based on children's current understandings. Numerous strategies are available to use (1) at the beginning of a lesson to elicit student thinking, (2) during a lesson to confront student conceptions with those of their peers or with experimental observations that provide new evidence that challenges their explanations, and (3) after the learning experience to assist in sense-making; these strategies serve as moment-by-moment assessments to guide learning and modify instruction (see

Internet Resources).

Consider this brief example. A lesson begins with a concept cartoon providing various explanations that reflect common preconceptions about what happens to food animals eat. Students choose from these options and explain to peers which explanation they think is best. Teams then reach consensus about the best explanation. They design an investigation to test their explanation, measuring changes in an organism over time when fed. During and after the investigation, students revise explanations based on the evidence they gather. They then use reading strategies to compare their thinking with a scientific explanation, which explains that food gets changed and becomes part of the organism.

Among various strategies, inquiry can confront student conceptions with evidence that conflicts with the explanations they bring to the lesson. Consider specific strategies that help students make sense of inquiry—both during and after the experience. Too often children are offered hands-on activities that exclude not only opportunities to share reasoning and explanations during the experience but also comparison of their explanations to scientific explanations after it. Science notebooks, cooperative group work, and student presentations are strategies that promote sense making. Remember that inquiry is not always hands-on. Students can refine their explanations through data sets the teacher provides or through reading and analyzing text.

Integrate With Language Arts and Mathematics

Integration of language arts and mathematics with science not only helps students understand science but also increases time available for science instruction in the elementary classroom. Common reading strategies help students make sense of and communicate science experiences while strengthening reading skills. Mathematics is essential to gathering and making sense of data. For example, the study of change in motion using ramps and cars depends on understanding place value, whole numbers and decimals, and measuring time intervals. Informational text helps students develop and provide evidence for explanations, explanatory writing is core to communicating their explanations, and discourse is essential as they summarize and present ideas.

Consider the four strands of science learning as outlined in *Ready, Set, Science!* (Michaels, Shouse and Schweingruber 2008). Reading, writing, speaking, and listening are core to understanding scientific explanations (Strand 1), reflecting on scientific knowledge (Strand 3), and participating productively in science (Strand 4). It is difficult to generate scientific evidence (Strand 2) without the use of mathematics. Integration of science, mathematics, and language arts strengthen students' abilities to develop models and explanations as they make sense of the world around them.

Final Thoughts

When teachers encounter science concepts that are difficult for their students to learn, it helps to focus on student preconceptions, use a variety of strategies that provide multiple opportunities to explore a concept, thoughtfully incorporate the practices of science, and provide a safe learning environment that lets students find their voice in the scientific realm. Identify any one of these areas as you consider ways to change your instructional practice, work to learn more and apply what you learn in your classroom and you will likely see benefit to your students through increased engagement and understandings. ■

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References

Duschl, R.A., H.A. Schweingruber, and A.W. Shouse. 2007. *Taking science to school: Learning and teaching science in grades K–8.* Washington, DC: National Academies Press.

Michaels, S., A.W. Shouse, and H.A. Schweingruber. 2008. *Ready, set, science! Putting research to work in K–8 science classrooms.* Washington, DC: National Academies Press.

National Research Council (NRC). 2011. *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

Internet Resources

Integrating Technology Into the Classroom Using Instructional Strategies
www.tltguide.ccsd.k12.co.us/instructional_tools/Strategies/Strategies.html

NSDL Science Literacy Maps
http://strandmaps.nsdl.org