MEASURING UP TO STANDARDS

Across the region, states hone their science standards and assessments.

BY MARILYN DEUTSCH

PORTLAND, Oregon—If physics is how things work, then the physics of how students work and learn in Bonnie Magura's eighth-grade physical science class can be summed up in these four words: motion, energy, thought, and creativity. Magura rarely sits or stands behind her desk lecturing. Rather, the 2003 Presidential Award Winner for Excellence in Math and Science Teaching spends the bulk of her instructional time alongside her students teaching them how to "do" science. Today, the lesson is on energy transfer and conversion: The students are building wind turbines based on their own designs.

While across the United States science educators are feverishly grappling with the challenges, demands, and time constraints of creating science standards and assessments mandated by the No Child Left Behind Act, there is no such panic in Oregon. NCLB requires states to have their science standards in place next school year and to test students on these standards by 2007–2008. Students must be tested at least once in grades 3–5, 6–9, and 10–12.

Oregon adopted new science standards back in 2001, although they're frequently reviewed and revised in a continuing process of raising and rising expectations. Educators in the state believe they've found a successful formula for K–12 science education, based on the claims-evidence approach to "inquiry-based" science.

INQUIRING MINDS

Inquiry-based instruction is more than just hands-on learning. Proponents say this teaching approach encourages critical thinking. Before starting any scientific inquiry, teacher and students write "claim statements." For example, this is the claim statement for the wind turbine project in Bonnie Magura's classroom:

"Energy cannot be created nor destroyed but only changed from one form to another. Mechanical advantage plays a role in how efficiently energy can be transferred or converted to new forms."

Photo by Jostein Hauge

Teachers like Magura say the claim statement is key to students developing deep scientific understanding. The claim gives students a concept to test and guides them as they collect and analyze their data.

Dave Hamilton—who has taught science for 26 years—has worked with teachers around the state on implementing the claims-evidence approach. A teacher at Portland's Franklin High School, Hamilton says the claim statements are "powerful because they anchor the entire investigation," so that students look for evidence that either supports or refutes their claims.

For teachers, inquiry-based science may require more up-front planning, but it is the only way Magura has ever taught. She says, "You have to let go and let students struggle and do it, fail, pick it up again, and do it …" and in the process, help them learn that it's OK not to succeed the first time. Magura provides the point-to-point checks that keep her students focused and on track.

PUTTING INQUIRY TO THE TEST

To find out how well Oregon science students are doing, the state has devised two sets of tests. There's the traditional multiple-choice test given in fifth, eighth, and 10th grades with both a paper-and-pencil format and a Web-based version. However, a second test defies traditional A, B, C, or D answers. Students must submit work samples that demonstrate whether they can clearly and concisely pose a scientific question, state their hypothesis, proceed with an experiment, show data and results, graph tables, and reach a conclusion. Work samples are scored on a scale of 1–6. A score of 4 meets standards while scores of 5 and 6 exceed standards.

One work sample provided by a fifth-grader looking into the nature of magnetism and magnets asks, "Does the edge of a circular magnet have the same strength/magnetic force as the north and south pole of that same magnet?" The student hypothesizes that he doesn't think the edge of the circular magnet will be equal in force to the north and south magnet poles. The question and hypothesis rate a "5" from the scorers because they're stated clearly and show that the student understands what he's doing.

Another student looks into the relationship between sunlight and the growth of seeds, but never poses a clear question. Instead, the student writes, "For my question, I am going to do sunlight and no sunlight." This work sample rates a "2."

Teachers—not state testers—evaluate these samples, looking for a student's understanding of science that goes beyond content. Hamilton says, taken as a whole, Oregon's assessment tests give teachers, students, and parents a "more complete picture of student achievement."

But does this work? In the two years of testing, science achievement has actually slipped a couple of percentage points, from a high of 71 percent of fifth-graders meeting and exceeding state standards in 2001–2002 down to 69 percent in 2003–2004. Eighth-graders and 10th-graders slipped one percentage point to 58 percent and 59 percent, respectively. Oregon's Science Assessment Specialist Aaron Persons says with just two rounds of testing, there aren't enough data to draw any conclusions.

Photo by Marilyn Deutsch

Kate builds a wind turbine in Bonnie Magura's eighth-grade class.

However, preliminary testing elsewhere across the nation suggests that inquiry-based science teaching not only improves students' scientific knowledge, but also has other benefits: Students who learn this way show marked improvements in their reading and math scores.

Still, it is estimated that 80 percent of schools across the United States take a more "textbook" or direct approach to science instruction. And some researchers and educators believe this more "direct style" of teaching is best suited for complex science lessons.

As NCLB focuses on science, the critical discussion will continue over the best ways to teach science to elementary and secondary school students: inquiry/discovery, the direct approach, or a combination of both. In Oregon, however, the road ahead is already charted. At West Salem High School in Salem, Oregon, science teacher Steve Holman sums it up. Science, he says, is "a process, where the critical thinking you learn from science will stay with you longer than your ability to recall the periodic table."

For more on Oregon's benchmarks and standards, see www.ode.state.or.us/teachlearn/subjects/science/standards/.

Around the region, the states are taking various approaches to developing standards and assessments. Here's a brief round-up:

ALASKA

www.educ.state.ak.us/ContentStandards/Science.html

By spring 2005, Alaska's Department of Education and Early Development should give its stamp of approval to new science content standards. Educators have come up with a two-page draft that focuses on science as inquiry and knowledge. It lists concepts every child should learn in the following areas:

- Physical, life, and earth sciences
- Science and technology
- History and nature of science
- Relationship of science to cultural/personal perspectives

Educators are now developing grade-level expectations. Teachers are encouraged to use "inquiry-based" science but that teaching approach is not mandated. Alaska favors local control, so each district is responsible for its own curriculum based on statewide standards. Currently, there are no statewide science assessments although some of the state's 53 local school districts do conduct their own tests.

No decision has been made yet on how to assess these standards for Alaska's 135,000 public school students. Assessment Administrator Cathy Anderegg says Alaska is considering both multiple-choice and "constructed response" items (short and/or long written answers) for the science assessment. Anderegg promises, though, that Alaska will meet the 2007–2008 NCLB assessment deadline.

IDAHO

www.sde.state.id.us/dept/standards.asp

Like Oregon, Idaho has had its science standards in place since 2001. Carissa Miller, assessment program manager for the Idaho State Board of Education, says the state is not changing these standards in light of NCLB. But assessments are another matter.

The state has contracted with Northwest Evaluation Association (NWEA) to come up with a 64-question, computer-driven multiple-choice test.

State Science Coordinator Kevin Collins explains that a lot of work has gone into "filtering" the state standards and deciding which ones to test. Given that it takes a minimum of six questions to determine if a student has mastered an individual standard, Idaho will only be able to test 10 standards. Collins was given the gargantuan task of identifying those 10 "power standards" that were so important they had to be tested and that were used by NWEA to come up with a blueprint for the state assessments. Teams of Idaho teachers drafted questions on the power standards that will be used in the assessments, along with questions already in NWEA's item bank.

Idaho plans to test students two or three times a year. In the fall, they'll be given a "levels" test that works like this: If a student answers a question correctly, the computer will then ask the student a tougher question—and on and on—until the tester gets a good idea of the limits of the child's knowledge. In the spring, students will take a blended test with 40 questions that conform to NCLB reporting requirements and another 24 levels-type questions.

Miller says "performance-based tests" such as Oregon's work samples are expensive and difficult to do, and she questions the reliability of those assessments.

It's a "give and take," she says. Idaho educators think their computerized multiple-choice test will give teachers information they need on each child's progress quickly, and teachers can use the results prescriptively to guide instruction.

MONTANA

www.opi.state.mt.us/pdf/Standards/ContStds-Science.pdf

Montana's current science standards were developed prior to the passage of NCLB as part of a comprehensive effort by the Board of Public Education and the Office of Public Instruction (OPI) to ensure a comprehensive alignment of state standards and assessments, and district curricula, assessments, and instruction. In the first phase of the project, K–12 content and performance standards were developed for all the curricular areas, including science. Benchmarks were designed at three grade levels—fourth, eighth, and upon graduation—to measure progress toward meeting those standards.

According to Judy Snow, the state assessment director at OPI, the process gave districts and schools the opportunity to participate in a local dialogue—both in the education community and the community at large—to determine the essential learning for students at each grade level to meet state benchmarks and standards. "It was designed to promote and ensure the development of local curriculum that would be aligned to the state standards," Snow says.

Montana then moved to align the standards with statewide assessments, mandating that districts use the Iowa Tests in grades four, eight, and 11. Acknowledging that Iowa Tests are limited in measuring how students apply their skills, Montana is now in the process of developing a criterion-referenced test (CRT). Snow says that with the passage of NCLB, the timeline for accomplishing that task has been accelerated. The reading and math components have been developed and were used for the first time in grades four, eight, and 10 in spring 2004. The science component is now under construction.

The state has contracted with Measured Progress of New Hampshire to help develop the CRT. The company has

See STANDARDS, *page 39*

Aligning Assessment and Standards

States across the country are scrambling to develop assessments, yet there's little guidance in this difficult process. As Project 2061 of the American Association for the Advancement of Science (AAAS), points out, there is "no useful synthesis of the latest thinking on assessment, much less practical advice on how to judge alignment of assessment with learning goals."

Project 2061—named for the year when Halley's Comet will be visible on earth again—is now engaged in developing such guidance. With a grant from the National Science Foundation, Project 2061 is drafting criteria and an analysis procedure for judging alignment.

In an earlier publication—*Blueprints for Reform: Science, Mathematics, and Technology Education*—AAAS set out the following general recommendations for assessments:

- Include different techniques
- Encourage students to go beyond memorizing facts
- Include problem-solving opportunities

For more, see www.project2061.org/research/assessment.htm

Standards

Continued from page 15

worked with more than 20 states on various assessment processes and instruments. During the summer of 2005, Montana educators will review current science standards. It's expected that the science CRT tests will be administered in spring 2008.

Along with developing the CRT, Snow notes, the state has also facilitated the development of a continuous education improvement process for all districts and schools. "[We're] confident that the time spent developing this improvement process has been productive and will improve student achievement in all areas, including science," she says.

WASHINGTON

www.k12.wa.us/curriculumInstruct/Science/default.aspx

Washington, like Oregon, is ahead of the curve when it comes to science education and NCLB. Assistant Superintendent for Assessment and Research in Washington's Office of the Superintendent of Public Instruction Greg Hall says standards and assessments are already in place and that NCLB is not having an impact on the state's teaching or testing of science. However, the science standards in Washington are creating the need to shift science education to ensure that instruction, curriculum, and assessment are aligned.

Hall admits that science education in Washington's elementary schools has been "spotty at best." In fact, he says science education was pretty minimal in the state's public schools until the middle school level. But that's changing. During the last two years, the state implemented standards in grades five, eight, and 10 and by 2010, Washington students will have to meet the standard on the 10th-grade science test to get their high school diplomas.

New testing started for eighth- and 10th-graders last year. It was optional for fifth-graders but will be required in 2005. Students take a 45-question multiple-choice, short answer, and extended answer test.

Hall says, "We have our work cut out for us." According to last year's results, only 38 percent of middle and high school students are meeting the state's new, more rigorous standards. In elementary school, the results are even more dismal: Just 28 percent of fifth-graders met the science standards. Still, Hall says Washington public schools will hold firm on these standards while the system catches up.

Washington is not currently considering scoring work samples the way Oregon does. However, Washington teachers are directly involved in scoring the written response questions on the state tests. While inquiry-based science is considered one part of the state curriculum, teaching methodology is left up to the individual teacher or is guided by the district. Hall observes that Washington "still has a long ways to go" in meeting science standards but everyone is "off and running and eagerly meeting the challenge." ■

PHYSICS

Continued from page 19

necessarily creative. It's creative in a sense but it's just hard scientific work and it pays off."

He points to several models of towers and boomilevers made out of balsa wood that sit on a top shelf in his classroom. They are lovely to look at, these designs of simple engineering. The objective in the tower-building competition in Science Olympiad is to build the lightest tower with the most structural efficiency that can support a load of up to 15 kilograms—about 33 pounds. These designs won high marks in the competition last year.

"Being an engineer, I can spot these kids, the kid who will take something like that and focus on it and never quit. Some of the projects have hundreds of hours put into them."

"Retreads"

Moving from a professional science career into teaching isn't a piece of cake, but it does have its advantages. Twenty-five years of experience with military bureaucracy taught Neznanski how to write terrific proposals, and he's turned that knack into successful grant-writing. When he set out to find funds to build up the physics lab, "I shot for the sky," he says. His aim was true. The lab now is equipped with $80,000 worth of equipment—computers, software, probes, gauges, calculators, you name it—thanks to the likes of Hewlett-Packard, the Wiegand Foundation, and the BK Booster Club.

But the best knack Neznanski brought with him into the classroom was an innate talent for teaching young people, says former mentor Henry Krewer.

"A lot of teachers want to do a job and they want to walk out feeling good, forgetting how the kids walk out: They walk out baffled, they walk out upset. If you feel like, 'Oh, I did a great presentation; that was clever and that was wonderful,' the kids don't know anything about that. Larry was the other way. Larry wanted to know that every kid in the room knew what he was talking about. I think that was the biggest gift he gave to the kids."

And the best way he's found to teach is to relate physics ideas to the real and sometimes exciting world of work, where such things as repositioning a satellite in space is apt to capture the imaginations of young minds.

"That's one of the reasons why I think that 'retreads' are worthwhile," he says. "There is an element that you can bring into the classroom that's important, and that is what's going on outside [school] that students might want to do someday."

That interest may play out for a lifetime.

"I think that's where a lot of the motivation comes from. If you can get a kid to do something in science that they never thought they could do … those are life forces that are so valuable that you can't quantify them." ■