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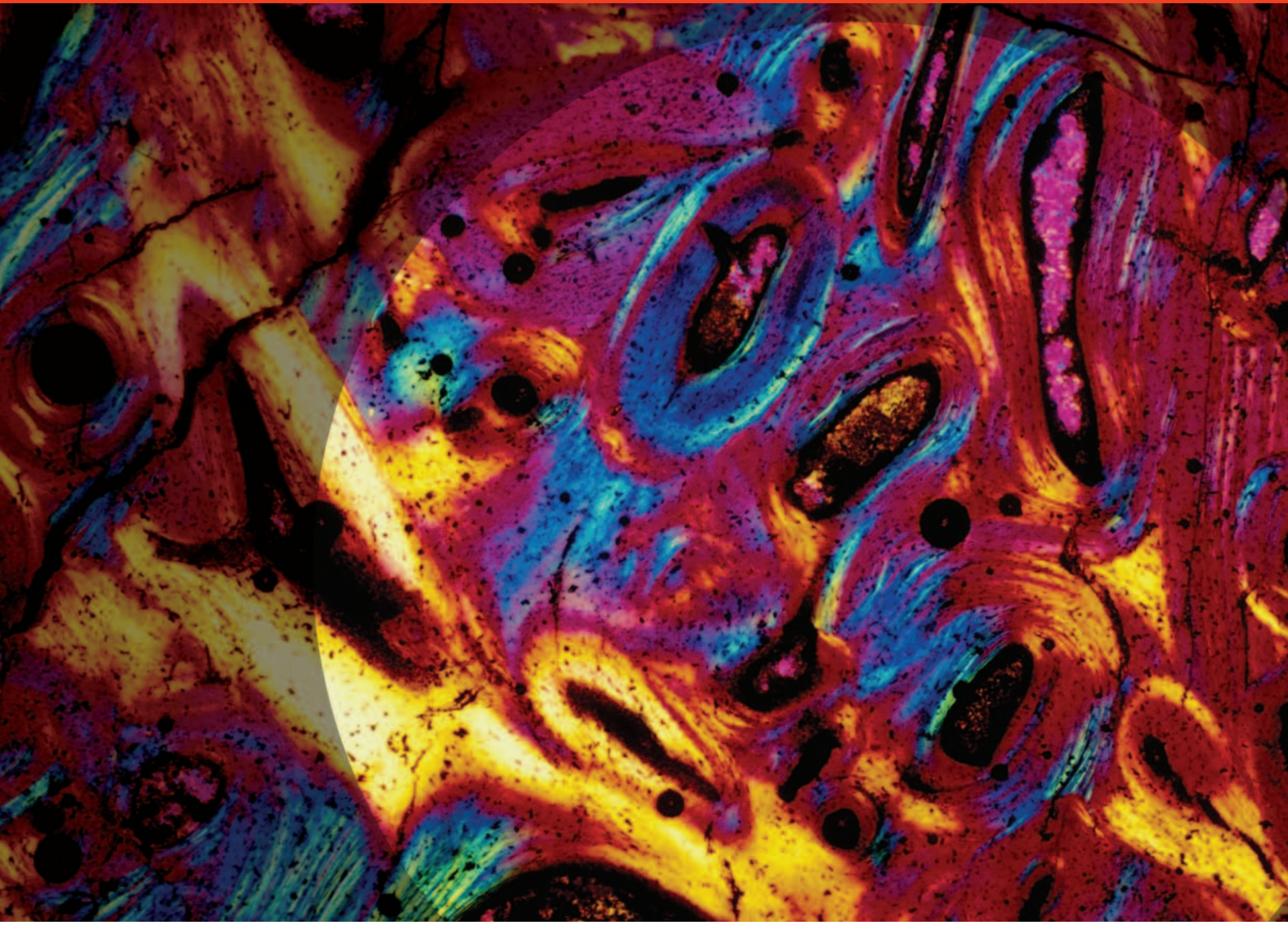
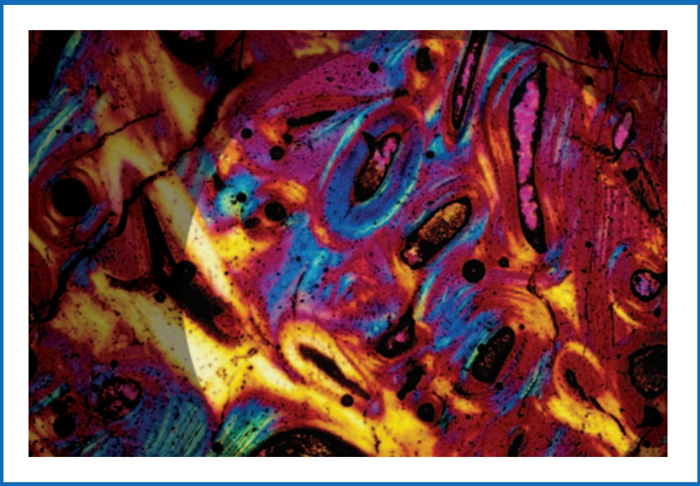


SCIENCE UNDER THE MICROSCOPE



ON THE COVER

A photomicrograph captures the abstract beauty of a dinosaur bone. Under polarized light, thin sections of the bone produce brilliant colors. You can find more fascinating images of ordinary and unusual objects, recorded through an optical microscope, on an extensive Web site maintained by Florida State University at http://micro.magnet.fsu.edu/index.html

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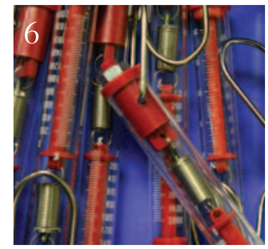

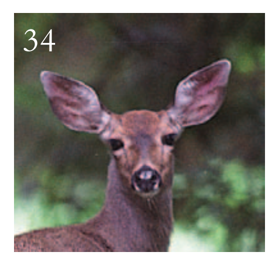

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On the Web
Northwest Education is available online in both PDF and HTML versions at www.nwrel.org/nwedu. Look for Web exclusives, marked with .

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Statement of Purpose
Northwest Education aims to promote a regional dialogue and to elevate teaching and learning by giving readers the best information, ideas, and personal stories from practitioners, researchers, and other experts.

FORUM

Photo Facts

I worked in the REACT (Relevant Educational Applications of Computer Technology) program from 1969 to 1973 at NWREL. I, for sure, remember the teletype machines. How far we have come! I can tell you two of the people in the photograph on page 45 (of "Online Schools: A New Frontier in Public Education," winter 2004). The tallest man in the back is Cliff Winkler who was on the REACT staff. The furthest right (with his arms folded) is Chet Hausken, who at the time directed the Small Schools Program.

Winston Addis
Vice President, External Relations
City University
Bellevue, Washington

Nurturing Native Students

Kara (Briggs) has hit home with a very serious issue: high school dropouts (in "Slipping Through the Cracks," spring 2004). This has been a concern for educators for many years. As readers and educators, we need to respond to how we can stop this, raise the self-esteem of our Native children, let them believe that they are worthy, start the healing process of our past, and enrich the futures of those yet to become who they should or aspire to be.

I am a Quileute Tribal Member. I worked at our tribal school for nine years and then went back to college as a single mother of three. I persisted and now have my bachelor's degree in speech and hearing sciences. I found Kara's article to be an outcry to our educators, teachers, administrators, and parents. We must start the healing NOW, move forward to brighter possibilities, and not let any more children slip through the cracks.

Joanne Harrison
Research Assistant
University of Idaho
Moscow, Idaho

On the Trail of Lewis and Clark

Excellent article ("Many Nations," summer 2003). [I] appreciate information on the methods of teaching and the approach being taken toward bringing Lewis and Clark to older students of a diverse nature. The study of the Lewis and Clark expedition seems to have no bottom as historians, educators, authors, and speakers, such as myself, dig deeper and continue to find new avenues of understanding and learning. I belong to the Lewis and Clark Trail Heritage Foundation, both the national organization and the Philadelphia chapter. Our annual meeting is set for Portland, Oregon, August 6–10, 2005. I'm referring the article to both organizations as an FYI since the Oregon chapter is mentioned in the article and they are hosting the meeting in August. Thanks again for posting a wonderful article.

Lorna Hainesworth
Baltimore County Library & Senior Centers
Randallstown, Maryland

We want to hear from you! Send your letters to the editor, article ideas, and tips on places where good things are happening to nwedufeedback@nwrel.org. Letters may be edited for length or clarity.

EDITOR'S NOTE

Photo courtesy OMSI

On a recent rainy day visit to a Northwest science museum, I watched toddlers happily navigate an exhibit called the "Science Playground." Armed with a pail and shovel, one child explored the physics of sand, intently watching as the grains rearranged themselves each time he dipped into the sandbox. Across the room, a little girl experimented with a water wall, spinning wheels and turning valves as the stream flowed over, around, and through the obstacles.

"Young children are more scientist than anything else," observed the late Herbert Zim, a professor and editor of the Golden Nature Series of small books that introduced countless youngsters to the wonders of the natural world. Indeed, from the earliest age, children are actively manipulating and interacting with their environment, trying to make sense of things. The barrage of questions seems endless: How does this happen? Why does this happen? What happens if I change things around?

Albert Einstein warns us, "The important thing is not to stop questioning." But, that's exactly what occurs as the child grows older and loses that natural curiosity. One study asserts that 57 percent of our students get "turned off" to science by the time they reach seventh grade.

Why is that such a troubling statistic? One reason simply is that developing scientific literacy is critical today and will become increasingly so. Not only does science personally affect our lives through the physical world, medicine, and technology, but it's also at the heart of some of the thorniest ethical issues we face as a society. From global warming to stem-cell research, nuclear capabilities, and the depletion of fossil fuels, the citizens of the 21st century will be called on to make decisions that require an understanding of the basic laws of the universe and the capacity to weigh evidence-based arguments.

Underscoring the importance of science education, the U.S. Department of Education is training a spotlight on the subject. Under the No Child Left Behind Act, states must develop science standards by 2005–2006. Beginning in the 2007–2008 school year, states are required to administer annual science assessments at least once in elementary, middle, and high school. These assessments must be aligned with state standards and involve multiple measures, including higher order thinking and understanding.

In this issue of *Northwest Education,* we look at how our region is preparing to meet the NCLB challenge. "Measuring Up to Standards" describes Oregon's unique "claims-evidence" approach to science instruction and assessments that incorporate work samples. We also see how Washington, Montana, Idaho, and Alaska are setting their own course.

On the campus of Western Washington University we're introduced to a bold initiative to transform the way students and teachers are taught scientific principles. We travel to frozen Alaska—where polar bears are just one of the complications of field trips—to find out how students are collecting important data for a university geophysicist. And, at one of the nation's oldest outdoor education programs, we camp out in an Oregon forest where sixth-graders learn enduring lessons about the environment and themselves.

In interviews with some of the Northwest's outstanding scientists, we're reminded of the role that teachers play in nurturing groundbreaking biologists, geologists, physicists, and chemists. Someday—with any luck and good teaching—that young child who marvels over the way sand particles filter through a sieve may turn out to be the next Newton, Watson, or Curie.

—Rhonda Barton, bartonr@nwrel.org

SCIENCE UNDER THE MICROSCOPE

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Lisa and Craig Harpel—a married couple who both teach science at Mt. Vernon High School—team up for a physics lesson at Western Washington University. The summer academy showed Lisa, "Rigor doesn't have to mean more vocabulary words. It can be asking students what their fundamental understanding of a concept is: asking them to go to the edges of their thinking and explore what they do and don't know."

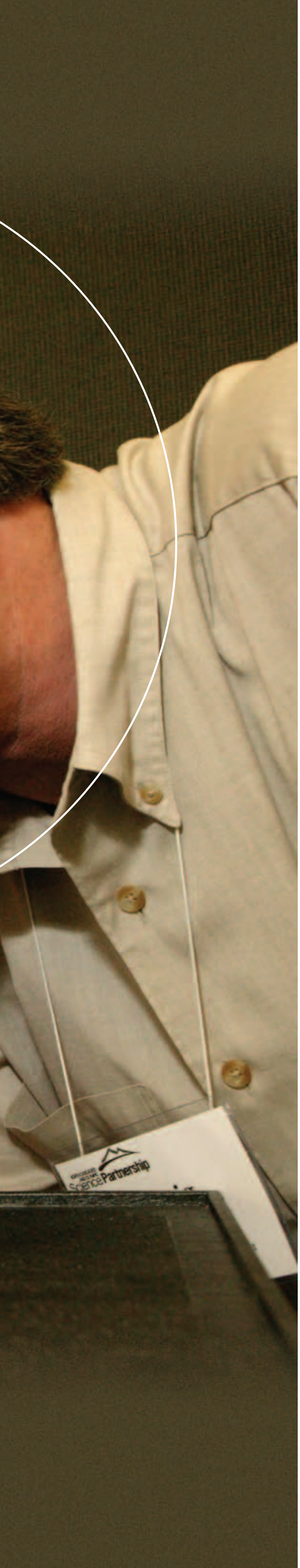

Photo © WWU Publishing Services/David Scherrer

A Meeting of MINDS

With a focus on inquiry-based methods, an ambitious partnership sets out to transform science education in northwest Washington.

BY RHONDA BARTON

BELLINGHAM, Washington—It looks more like a preschool setting than a university classroom: Little plastic tubs of thick yellow dish-washing detergent are lined up at each seat, with red- and white-striped plastic straws just waiting to dip into the sticky liquid. At the signal, everyone leans in and begins to blow. Bubbles—large, small, pink, clear, and iridescent—start gurgling up, filling the containers, and escaping into the air.

Dorothy "Dottie" Simpson, a small woman with a large presence, paces in front of the blackboard and asks, "What questions do you have?" The "students"—actually elementary through high school teachers—excitedly shout out: Where does the color come from? Why are some bubbles small and some large? Why do some pop and others don't? Why are they hexagonal? What makes bubbles last?

Welcome to introductory physics.

The bubble lesson is one exercise in a two-week academy held this summer on the campus of Western Washington University. It's the opening volley in a five-year, $12 million effort—funded by the National Science Foundation—that seeks to improve science teaching and learning in both the K–12 school system and higher education. Called the North Cascades and Olympic Science Partnership—or NCOSP for short—the unique project unites 28 predominantly rural school districts, two educational service districts, three community colleges, Washington State LASER (Leadership and Assistance for Science Education Reform), Northwest Indian College, and Western Washington University.

According to NCOSP leader George "Pinky" Nelson, the partners are set to attack a systemic problem. Few elementary teachers graduate from university ready to teach science effectively while secondary teachers have substantial content knowledge but little experience with research-based curricula. Nelson—who heads Western Washington's SMATE (Science, Mathematics, and Technology Education) program—believes, "You can't separate the content and the pedagogy. You have to focus on learning science, but in a context of teaching it better."

The launch of NCOSP comes at a time when pressure is mounting to improve student science achievement in Washington. Starting in 2010, students must pass the 10th-grade science WASL (Washington Assessment of Student Learning) to earn a diploma. This year, a science assessment will be required, for the first time, for students in fifth grade; last year, tests were mandated at the eighth- and 10th-grade levels.

Through its efforts during the next five years, the partnership expects 90 percent of students in participating school districts to meet or exceed the state science standards. And, they're forecasting other ambitious outcomes as well: 147 teacher-leaders will complete 360 hours of professional development, another 1,000 teachers will receive 86 hours of training, and 90 percent of teachers will use research-based curriculum as intended. In addition, new science content and methods courses will be in place at the university and community college levels and the number of preservice teachers from underrepresented groups will double.

Behind all those numbers is a mission to fundamentally change teachers' ideas about science. "At the extreme, it's a movement away from thinking about science as a collection of facts, vocabulary, and formulas into a deeper understanding of the whole nature of science: the use of evidence to support ideas, a questioning of observations to make meaning of the natural world," says Project Director Carolyn Landel. "It's a real paradigm shift in terms of [moving from] teaching science's terms and words and descriptors to teaching a way of thinking and knowing and exploring the world."

"It's a real paradigm shift in terms of [moving from] teaching science's terms and words and descriptors to teaching a way of thinking and knowing and exploring the world."

—Carolyn Landel

In Dottie Simpson's classroom, the exploration of bubbles has segued into an animated discussion of inquiry learning. "Give a situation that gets [students'] curiosity going," Simpson exhorts the class. "Ultimately, you want them to ask the questions. If you're in the habit of telling them stuff, instead of directing the questioning, then get over it!"

Simpson, a retired physics and math instructor who's part of the NCOSP faculty, gives the teachers plenty more advice: Work on your "wait time" and don't rush in to fill the gaps; discourage questions that elicit one-word answers; emphasize the evidence for ideas and thoughtfulness about observations; ask "checking questions" to determine the class's thinking at the moment; and respect all students' ideas. She concedes that "you can't use inquiry all the time—you have to pick and choose." But, by engaging the class in asking questions, you can turn them into "active listeners" when the lesson calls for a lecture.

Sue Claypoole-Brooks, a Lynden middle school teacher who's been in the trenches for 18 years, comes away from the session with renewed empathy for her seventh- and eighth-graders. "It's so valuable for a teacher to become a student—to reflect and grow from that," she remarks. "I can start thinking about what my kids are going through."

That role reversal surfaces again and again as clusters of teachers work their way through experiments with magnets, electricity, and motion. For many, physics is a foreign language—which is precisely why it was chosen as the focus of the first academy.

"The most important thing we wanted our participants to have was the opportunity to truly experience learning and more deeply understand the process they've gone through to help them develop new ideas and establish a deeper conceptual understanding of some fundamental ideas," says Landel,

Photos © WWU Publishing Services/David Scherrer

a former cancer researcher. "The more they understand about their own learning, the more it helps us make that next step to how their students learn."

Landel strolls through a lab where teachers puzzle over the effect of force on two different masses. Intense concentration mixed with just a hint of frustration emanates from the room. Michael Shapiro and John Lahey, two elementary school teachers from Mt. Vernon, wonder if the way they've distributed weight has something to do with how two small containers move along a track. More tinkering and knitting of brows follows this theory. Maybe, Shapiro speculates, the position of a nearby fan is affecting their results.

Like their colleagues, Lahey and Shapiro are encouraged to make predictions, figure out how to test them, observe the results, come to conclusions, try new experiments, make more observations, and modify their conclusions in a continuous cycle. It's a constructivist approach where learners are asked to examine their preconceptions and then construct new, more accurate knowledge.

The plan is that Lahey, Shapiro, and other "teacher-leaders" at the academy will return to their own schools and share such constructivist, inquiry-based models with their peers. The teacher-leaders will continue to receive training in summer academies and during the academic year. They'll also be able to tap into Western Washington's resources and get support from higher education scientists and six full-time Teachers on Special Assignment (or TOSAs) who serve as liaisons between the university and school districts.

Bainbridge Island was one school district that wasted no time in sharing the lessons of the summer academy. The 4,000-student district sent nine teachers to the NCOSP training. Joining them for a special one-day session were three high-level district administrators and 10 principals and assistant principals. It was the largest contingent of any district.

Associate Superintendent Faith Chapel says the experience was especially timely as Bainbridge Island prepares to introduce an all new K–12 science curriculum this year. "It was valuable for all our administrators, as they oversee implementation, to be on the same page as the teacher-leaders. As a group, we had a chance to hear some of the critical messages about eliciting students' thinking and activating prior knowledge. Also, it meant a lot to our teachers that (administrators) felt it was important enough to attend."

Just two weeks after the NCOSP gathering, Bainbridge Island held its own professional development training with materials from Western Washington. According to Chapel, 100 percent of the district's high school science teachers and 90 percent of the middle school teachers were there. "It's changed the level of our conversation," says Bainbridge Island High School Principal Brent Peterson. "In a general way, (NCOSP's) brought more focus to the discussion."

Throughout classrooms in the Olympic Peninsula and Whatcom and Skagit counties, the seeds planted by NCOSP are beginning to take root and grow. At Mt. Vernon High School, biology teacher and science department chair Craig Harpel reports that he's been working on his questioning skills. He's changing his instruction so there's more time to challenge individual students to think about "what they know, what they think they know, and why they think they know it."

"This hasn't been easy," Harpel admits, especially in a school where 44 percent of students qualify for free or reduced-price lunch. "This approach with large class sizes and very heterogeneous populations sometimes makes a teacher feel like a Superball in a box being shaken by a very unhappy gorilla. But under all the pressure there are those frozen moments when a truly surprised student says, 'Oh! I get it!' That makes me stop and think, 'Oh! I get it, too!'"

As for reaching low-achieving students and making those "aha" moments bubble to the surface, "NCOSP doesn't have any illusions that this is going to be an easy process," Harpel believes. "But (it's) convinced that with the application of education research, engagement, and collaboration at all levels, as well as sufficient resources, this can and will happen. I think they are right. … If we don't use the knowledge that is out there to teach more effectively, we are going to fail our students. It's as simple as that." ■

CHARTING A NEW COURSE:

George Nelson and Science Education Reform

BELLINGHAM, Washington—George "Pinky" Nelson is a veteran of three space flights who's spent 411 hours hurtling through the far reaches of the universe. But if you ask the former astronaut what his toughest mission has been, the answer is firmly earthbound. Glancing around his small corner office at Western Washington University, he confesses, "Actually this is the hardest thing I've ever tried to do—by far." *This* is overhauling how educators teach K–12 science and how universities prepare them for that job (see preceding story, "A Meeting of the Minds"). The boyish-looking Nelson, who holds a doctorate in astronomy and directed Project 2061 for the American Association for the Advancement of Science, talked to *Northwest Education* Editor Rhonda Barton about the importance of effective science education.

Q: *Reflecting on your own experience, what ignites a passion for science?*

From the time I was little kid—maybe four years old—I wanted to be an astronomer. It was genetic, so I don't expect students to be like me. My interest in education comes from going to lots of schools, seeing lots of kids, talking to lots of people, and seeing the impact of their ignorance on personal and political decisions. If our species is going to maintain its standard of living and survive, it's absolutely critically important that we have a foundation in science: just like it was critically important to know how to read at the turn of the 20th century. Prior to that, you didn't have to have a real understanding of learning or acquire new skills because you could still have a job for life. That just isn't true anymore. We don't know what to teach our kids to be productive 10 years from now because we don't know what jobs they'll do. We only know they won't be the same ones we have today. So, we need to teach people how to learn.

What can good science education accomplish that other subjects can't?

In schools, reading and writing tend to focus on the creative aspects—reading novels, developing expository materials, doing good creative writing—when in life, most of the reading and writing we do is not fiction. It's reading directions, writing instructions, and writing down ideas. In science, there's a big focus on communicating verbally and especially on communicating precisely in writing. That's an aspect that science demands. So, by doing good science, we can add to the language arts this component of learning to be precise. And you can't write precisely if you don't think precisely.

What about training the mind to question and observe?

That's a part of it: to develop these metacognitive skills, to say "I observe something, do I really understand what I saw? Does my mental model fit? Does it make sense? Do I have to revise what I think about something?" That's what science is all about. Those thinking skills are what we're trying to lead our teachers through so they know they need to do the same kind of thing with their students. A lot of people view science as just learning vocabulary, formulas, and facts. Certainly you have to do some of that, but that's a small part of understanding how the scientific enterprise works and how we learn about the world.

One of the goals of the North Cascades and Olympic Science Partnership is to reach all learners and help them succeed in challenging science curriculum that's aligned with state standards. How do you begin to achieve that lofty goal?

Slowly. I would claim today that 80 percent of the students who graduate from high school know almost nothing about science—probably a comparable percentage has similar math skills. Five years out of school, they will have forgotten every concept they learned. The 20 percent who do remember, I'm not so worried about—they're going to go on to college and do more work. But those who don't end up majoring in science or in engineering, the science they learned in high school—because it was a collection of facts or algorithms—will just fade away. They're going to fall back on their preconceptions. They aren't going to know why we have seasons, why we have phases of the moon, how we know the world is made up of atoms, or what evidence is. So, I'm really interested in curriculum that focuses on reaching all students—not just the top 20 percent, but the forgotten majority who we've kind of written off in terms of really learning.

Our work with these teachers is focused on identifying good curriculum and implementing it in a way that they're constantly monitoring the learning of all their students. As you said, it's a lofty goal, but I believe it's possible. Not tomorrow or the next day, but maybe many years down the road. It can't be done by individual teachers—that's why it's a partnership. We have to create these teams of players—the teachers in the schools, the university faculty, the communities—who are working together with the same notion. It's the good part of No Child Left Behind: We really don't want to leave any child behind. The community has to agree to that, and it has to do the hard work necessary to achieve that goal.

Photos © WWU Publishing Services/ David Scherrer

Given the advances in scientific knowledge and technology, how do we keep up or should we even worry about that?

Don't worry about it. What we really want to know is how does science work? What are some of the fundamental ideas? At the national level, we've got that down pretty good. It isn't necessary to know what's at the cutting edge. It's the same reason that we don't worry about what's at the cutting edge of novels in English today or what's at the cutting edge of thinking about history or linguistics. We're trying to give people the literacy core, the basic understanding that will allow them to read the newspaper, to appreciate an article

"We're trying to give people the literacy core, the basic understanding that will allow them to read the newspaper, to appreciate an article about what's going on at the cutting edge (of science), and to see if it makes sense or not."

about what's going on at the cutting edge, and to see if it makes sense or not. I know what's going on in my field of astronomy … barely. But I couldn't tell you what's at the cutting edge of geology or biology. I can read an article in the newspaper and appreciate what's going on. That's the level we want people to be at: to be able to understand statistical claims about drugs, politicians' arguments about environmental issues, or whatever to make an informed decision about their personal life.

So, do you think in 50 years, good science teaching will look like it does today?

Yeah. We'll have learned a lot more, so it will look different in that respect because we'll know more about how people learn, how to talk to people, and how to build good curriculum. Cognitive science has really been coming along in the last 20 years: We're starting to understand some things that are going to be enduring. ■

Read more about the North Cascades and Olympic Science Partnership at www.ncosp.smate.wwu.edu. The Web site includes a number of literature reviews on topics such as new teacher support, teachers as tutors, school leadership, and staff development.

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


150
20
40
250
300

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.

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

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Aligning Assessment and Standards

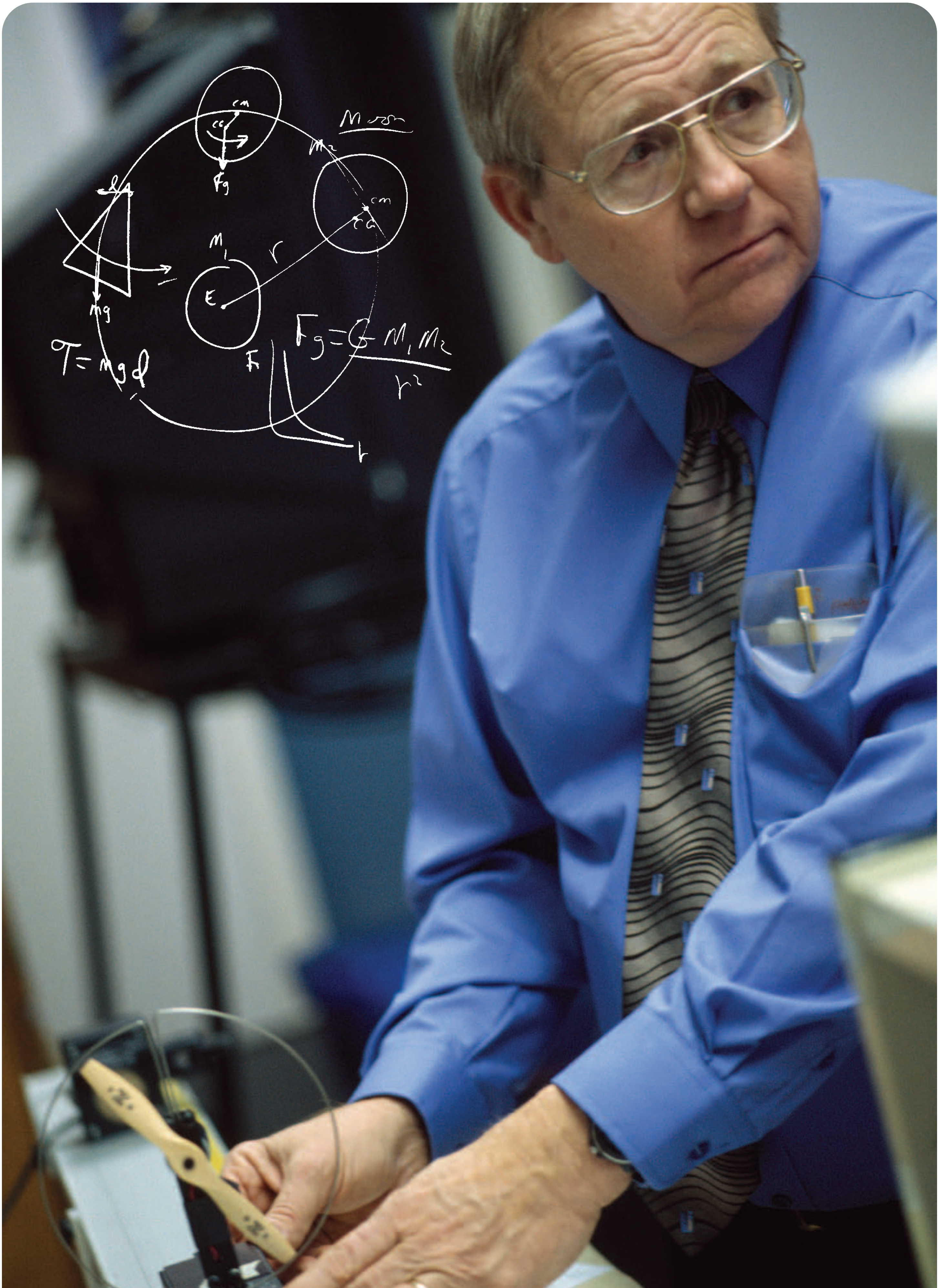
States across the country are scrambling to develop assessments, yet there's little guidance in this difficult process. As Project 2061 of the American Association for the Advancement of Science (AAAS), points out, there is "no useful synthesis of the latest thinking on assessment, much less practical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



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PUTTING PHYSICS FIRST

An award-winning Idaho teacher explains why students should start their high school education with physics.

STORY AND PHOTOS BY DENISE JARRETT WEEKS

BOISE, Idaho—The first place Larry Neznanski ever held class was underneath Lake Superior in the 1960s. He was in a copper mine, with the lake bed hundreds of feet above, when he found himself sharing a lunch hour with a group of seasoned electricians. They worked for the White Pine Copper Company, a massive mining and smelting operation that included its own power plant.

The industrial compound was beautiful to Neznanski's eyes. He'd just finished the undergraduate program at Michigan Technological University in electrical engineering and would be heading to graduate school at Purdue University at the end of the summer. Until then, White Pine had given him a summer job.

He remembers that day when a bunch of electricians stood around eating and began asking him questions. They were interested in this budding engineer, a kid really, and they struck up a conversation with him, asking about the science behind the electricity that they worked with every day.

"Guys were always asking about transistors and things, and they'd say, 'Well, we know how to use this stuff, but we don't know how it works.' So I thought, 'Well, *I* know how it works.' So I took out some of my texts and started putting stuff together. I'd go down there and these guys would be eating sandwiches, and I'd have my little board and I'd start teaching solid state physics. They loved it. So I did it for a whole summer."

From briefing room to classroom

After that summer, Neznanski went on to earn a master's then a doctoral degree in electrical engineering from Purdue and followed that with a high-flying military career in Cold War technology. It was thrilling and demanding, the life of a suitcase jock who researched, designed, built, and monitored satellite and missile systems for the United States Air Force. But 25 years after teaching those electricians in the mine, Neznanski found himself once again using his lunch hour to teach in an unlikely place: the physics lab at Boise's Bishop Kelly High School, Idaho's only Catholic high school.

It was 1990, and it seemed he'd stepped directly from the briefing room to the classroom. Still in his 40s, Neznanski had retired that spring as an Air Force lieutenant colonel, just as the Cold War was ending. By fall, he and his family had moved from Los Angeles to Boise and he was teaching physics and math, and coaching football at Bishop Kelly, or BK as it's known here.

That year, the Idaho legislature had passed a law providing an alternate route to teacher certification for industry professionals who wanted to go into teaching. Neznanski was the first to go through the program and BK snapped up his application, willing to take a risk that this military man would be a good addition to the faculty. Neznanski launched into his second career, calling himself a "retread" and soaking up all that he could from his teaching mentor, Henry Krewer, a much-loved chemistry and physics teacher at BK.

When Krewer retired, Neznanski inherited the physics lab. In short order, his lunchtime lessons began. The room would be empty at that time of day but for a clutch of inquisitive students and "Doc Nez," as the students had dubbed him. They'd be huddled at the blackboard or around one of the tables, talking about optics or thermal dynamics, or probing the incongruities of electromagnetism—things not normally covered in such depth in the regular physics course. Neznanski sensed that these kids, many not necessarily academic stars, could go much farther than the basics. So, he made an open invitation: Any student who wanted to plumb the deeper mysteries of how the world works could come to Room 17 at the lunch hour.

Physics first

Today, 15 years later, Neznanski teaches physics from first to last bell. He no longer teaches math or coaches football. Instead, in addition to teaching regular physics, he parlayed that lunchtime class, which he led for four years, into a two-year Advanced Placement physics course. And he persuaded his science colleagues—not to mention the BK administration—that conceptual physics needed to be taught to freshmen, *before* they study chemistry and biology. So, Neznanski—who was named a Micron Outstanding Science Teacher in 2003 and was selected the American Physical Society Distinguished Physics Teacher from Idaho in 1999—now teaches three levels of high school physics, and the number of physics students has gone from 14 to 125.

Creating the conceptual physics course for ninth-graders was a radical change to the curriculum. (Freshmen are now required to take either conceptual physics or earth science.) Neznanski was midway through the school year in 1993–1994 when he got the idea, and by fall he was teaching it. Credit the lightning-speed progress to willing colleagues, a private school's relative freedom to make curricular changes, and to one Paul G. Hewitt, says Neznanski.

Paul G. Hewitt is a retired physics professor whose widely used textbook *Conceptual Physics* promotes teaching physics to all students—not just to the top achievers—and teaching it earlier. Hewitt's views validated something Neznanski knew to be true from his own experience but that is still under-recognized in education: An understanding of basic physics ideas should form the foundation for studying chemistry and biology. In fact, some say the traditional sequence of teaching first biology, then chemistry, then physics has it backward.

It's long been believed that students need advanced algebra and calculus skills to do physics, but Hewitt, as well as such prominent physicists as Leon M. Lederman—a Nobel laureate who supports the "physics first" movement—believes that the basic laws of nature can be learned with minimal mathematical foundation.

As Hewitt tells students in the opening pages of his textbook, "Physics is about the rules of nature—so beautifully elegant that it can be neatly described mathematically. That's why many physics courses are treated as applied mathematics. But introductory physics that emphasizes computation misses something essential—*comprehension*—a gut feeling for the concepts."

Neznanski puts it this way: "It makes little sense to teach biology, chemistry, and then physics. Biology is the most complex of the sciences; it's the study of life. And we are chemical-based life forms, so you want students to understand physics and chemistry before studying biology.

"Chemistry is essentially the study of chemical bonding, but the forces and the atomic stuff behind that is pure physics. If you understand forces, it's easier to understand why particular atoms or molecules will bond the way they do. … If you understand vectors then you understand something about forces and that they have directions, and that will help you understand chemistry."

Guy Hudson teaches chemistry at BK. Before going back to college to earn a teaching degree, he worked as a scientist with Micron Technology in Boise. He says, "What I notice is that the kids who have taken Nez's class in conceptual physics, and have done reasonably well in there, are more prepared for my class because they're used to a little more critical thinking. They can relate several concepts and put them together, which is really the crux of chemistry. It's a really good prep course for those kids."

Taking physics before and concurrently with courses in algebra, precalculus, and calculus creates a wonderful synergy between the science and the math, says calculus teacher Wendy Dalrymple. As part of her graduate work in mathematics, she took several courses in physics, and she and Neznanski feel particularly in synch, regularly reinforcing the concepts each is teaching in their classrooms.

"The kids that have had conceptual physics and then go on to take further physics and are taking the math that goes with that … seem to have a bigger curiosity about how math works. Not to just find the number answer, but why something occurs," she says. "Especially in calculus, if I can do a physics problem and show them a method to find a number answer, and then show them the math, then we get to meld our disciplines together, and that's what works. Absolutely, it makes you a better math student to practice and have applications."

Physics for all

Not only are the kids who are taking physics at BK these days more diverse in their academic abilities, but also in gender. There are more girls participating than ever before. Forty-five percent of this year's entire freshmen class has elected to take Neznanski's conceptual physics course. Fifty percent of them are girls. While this is significant progress in getting more girls into this boy-dominated subject, girls' participation dips as the courses get more advanced. In regular physics, 30 percent of the students are girls, and in AP physics, that number drops to about 20 percent. Neznanski has observed that girls are often more interested in pursuing advanced biology than physics, but he can point to more than a few who have pursued physics and even gone on to study engineering in college.

And both boys and girls can be enthusiastic advocates for physics, and they struggle and triumph equally.

"I really don't like math and science usually," says Lilly, a freshman. "It's really not my thing. But physics is not so much a science and a math as a way of understanding … what happens [in everyday life]. So I think it's really interesting because it can be applied to almost anything. I can take this

In "Doc Nez's" second-period physics class, students gather for a quick group photo before breaking into teams to do an activity involving centripetal force.

and make it more advanced into chemistry and biology and all those other more complex sciences. Physics is, I think, a really good basic building block."

Roland is also a freshman this year. He doesn't consider himself a "science whiz" like his older brother, so he was surprised to find just how much fun physics could be in Doc Nez's class.

"When I came here I just got the crap kicked out of me. I mean, I did horrible at first, but once Doc kind of started to explain it, it got a lot easier. I like it a lot. I think it's really fun. He makes it so that something you see everyday, he compares it to that. Like we're doing atoms right now [and] he's kind of comparing it to planets and stuff like that. So it makes it a lot easier."

One thing's for sure, these students are beginning to see their world very differently.

"Everything else in life used to be simple!" says freshman Laura. "Everything's more complicated now because he just makes me think more."

Peter, an upperclassman, agrees, and tells an anecdote that sends him and his classmates into fits of laughter: "Rachel and I went to see the *Nutcracker* and for the first half of the ballet they were doing their dances, and I was thinking, 'OK, the center of mass is over their footprint. Their dresses are coming up because of differences in pressure—Bernoulli's Principle.' She leans over and says, 'Hey Peter, look: rotational inertia.' 'Yep, I been thinking of that the entire play!' Three years of physics ruins ballet, watch out!"

Science Olympiad

By turning the "regular kid" on to physics, Neznanski has helped to generate a lot of excitement about science in this school of some 600 students. About 45 students compete every year in the Science Olympiad, and five teachers and some steadfast parents devote considerable time coaching and traveling with them to competitions. Neznanski started the program at BK 11 years ago, and BK students have won the state competition nearly every year. When they make it to the national competition, they are frequent medalists and they were awarded the Spirit Trophy in 2002. Last year, the BK team brought home four national medals.

While some schools that participate in Science Olympiad recruit only the kids with high SAT scores, he says, "they're missing the kid in the middle, and they're the ones who need it the most. What I was looking for was something that an average kid could do that would turn them on to science. I'm not looking for your top students only. I don't care if a student is a hellion or has D's. I just want someone who's interested. They may not get A's, but they won't quit once they see they belong somewhere."

He continues: "The thing that makes a great scientist is that single-minded, total persistence and incredible dedication to work. Being able to do that hard work and do good science over many, many years and stay with it is not

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Igniting the Spark

BY IAN MCCLUSKEY

What lessons can we learn from outstanding scientists in our region? The path to a career in science—and even a Nobel Prize—is often guided by a curious nature, the ability to seek out challenges, and willing mentors—with a dash of serendipity. Some leading Northwest researchers share their stories and suggestions for teaching tomorrow's scientists.

FRANKLIN STAHL—
Construct Your Own Hurdles

James Watson was chatting with Francis Crick and some colleagues, when he pointed out the window, toward a lawn across the street, where one of his new summer students was mixing, selling, and drinking gin and tonics. "See that," he said, "That's Frank Stahl. He thinks he's pretty hot stuff."

The year before, Watson and Crick had published their seminal paper on the replication of DNA. That summer, in 1954, Watson and Crick were visiting researchers at the Woods Hole Laboratory in Massachusetts. Watson was teaching a physiology course, and the young man across the street, Franklin "Frank" Stahl, was his new student. Watson continued, "Why don't we give him a really tough experiment and see what he can do with it?"

"The poor guy," thought Matthew Meselson, who was working as Watson's assistant and was standing with the group. He wondered, *"Who was this student who had caught the eye of the world-famous Watson and Crick, and why would they want to throw him such a 'hot potato?'"* So Meselson decided to go down and meet Stahl. The two struck up a conversation about Watson and Crick's new theory on the proposed double helix structure of DNA, and the possibility of designing an experiment to learn how DNA replicates.

Previous ground-breaking studies had focused on organisms such as garden peas, fruit flies, and mice. Stahl became interested in bacterial viruses. With a countable number of atoms, bacterial viruses demonstrate all the basics of genetics, such as mutation, replication, and recombination. "People said it was just a fad, not something for professional biologists to study," recounts Stahl. His advisors told him there was no future in microbiology. "It wasn't just unexplored, but flat out denied," Stahl insists. "I saw a door. It wasn't clear to many, but it was to me."

Though Watson and Crick had cracked open the door with their landmark 1953 paper on the structure of DNA, the double helix model did not gain wide acceptance until Stahl and Meselson published the results of their experiment in 1958. Their experiment gave physical validity to a model that many scientists saw as speculation. Today, the double helix is an internationally recognized symbol of modern science. For his lifetime of work in DNA research, Stahl was awarded a MacArthur Fellowship, also known as a "genius award."

"The whole point of science is to overthrow conventional understanding to reach a deeper understanding," states Stahl, now an emeritus professor of biology at the University of Oregon. Reflecting back on his career, he has some strong advice for today's students: "Pursue your interests without regard to what others think you should do. Construct your own hurdles and jump them, rather than the ones placed in front of you. Question a teacher to the point you can understand a concept in your own terms. If you don't understand, keep questioning."

Stahl feels teachers can help start the process by getting students to ask questions. If he could offer one piece of advice to today's teachers, it would be to show students the experiments that fell apart, not just the successes. "The failed ideas are valid," he says. "Many failed ideas sounded promising when they were put forth. An experiment showing that a 'good' idea was, in fact, wrong frees us to look for a better one."

LINDA BUCK—
Encourage Obsessions

When Linda Buck's pet hamster died, the young girl buried it. She then tried to dig it back up to "see what it looked like." When her cat miscarried, she fetched her microscope from the basement. "I was always curious," the 57-year-old scientist explains.

Her father, an electronics engineer, was always trying to get his three girls to put down their dolls and build toy motors, operate amateur radios, and learn Morse Code. Her mother was a homemaker who loved puzzles, especially crosswords. Not surprisingly, Buck is known today for her analytical skills. "My mother used to complain I had a one-track mind," Buck recalls.

When Linda Buck was a teenager, she knew she wanted to help people, but she didn't know if science was the way to achieve that goal. When she graduated from Seattle's Roosevelt High School in 1965, her high school biology teacher wrote in her yearbook that she would make a "fine biologist one day."

Little did that teacher know how prescient her prediction was: This past December, Buck flew to Sweden to receive a 2004 Nobel Prize in the category of physiology or medicine. Buck, along with her colleague Richard Axel, has helped unlock the science of smell.

In 1991, Buck—who was then a postdoctoral fellow working in Axel's laboratory—discovered a family of genes that encode the odorant receptors of the olfactory epithelium, a patch of cells on the wall of the nasal cavity. Made up of some five million olfactory neurons, the olfactory epithelium sends messages directly to the brain, where they are processed as distinct scents, tastes, emotions, and memories. The discriminatory power of the olfactory system is immense; even a slight change in the structure of an odorant can alter its perceived odor, for example, from a hibiscus flower to sea salt.

Instead of hunting for the receptor proteins directly, Axel and Buck looked for genes that contained instructions for proteins found only in the olfactory epithelium. Their efforts produced nothing at first. Finally, Buck came up with what Axel calls "an extremely clever twist." She made three assumptions that drastically narrowed the field, allowing her to zero in on a group of genes that appear to code for the odorant receptor proteins.

Based on scattered evidence from other labs, Buck made the decision to narrow her search to a family of proteins called G protein-coupled receptors (GPCRs). Making use of a recently developed gene amplification technology, Buck then decided to conduct an exhaustive search for GPCRs in the olfactory epithelium. Further analysis narrowed the search to one candidate and Buck had found precisely what she had been looking for. Buck's cut-to-the-chase instincts obviated the need to sort through thousands of genes and, according to Axel, "saved several years of drudgery."

"I had tried so many things and had been working so hard for years, with nothing to show for it," explains Buck, who is a member of the Fred Hutchinson Cancer Research Center and an affiliate professor at the University of Washington in Seattle. "So when I finally found the genes in 1991, I couldn't believe it! None of them had ever been seen before. They were all different but all related to each other. That was very satisfying."

Having persisted in her quest to unlock the secret of scent for so many years, Buck tells students: "Pick a problem that you're extremely interested in. That sounds kind of simplistic maybe, but it's not, because you don't want to just do a problem because it's easy to solve, you want to do something that you're obsessed with, that you just have to understand."

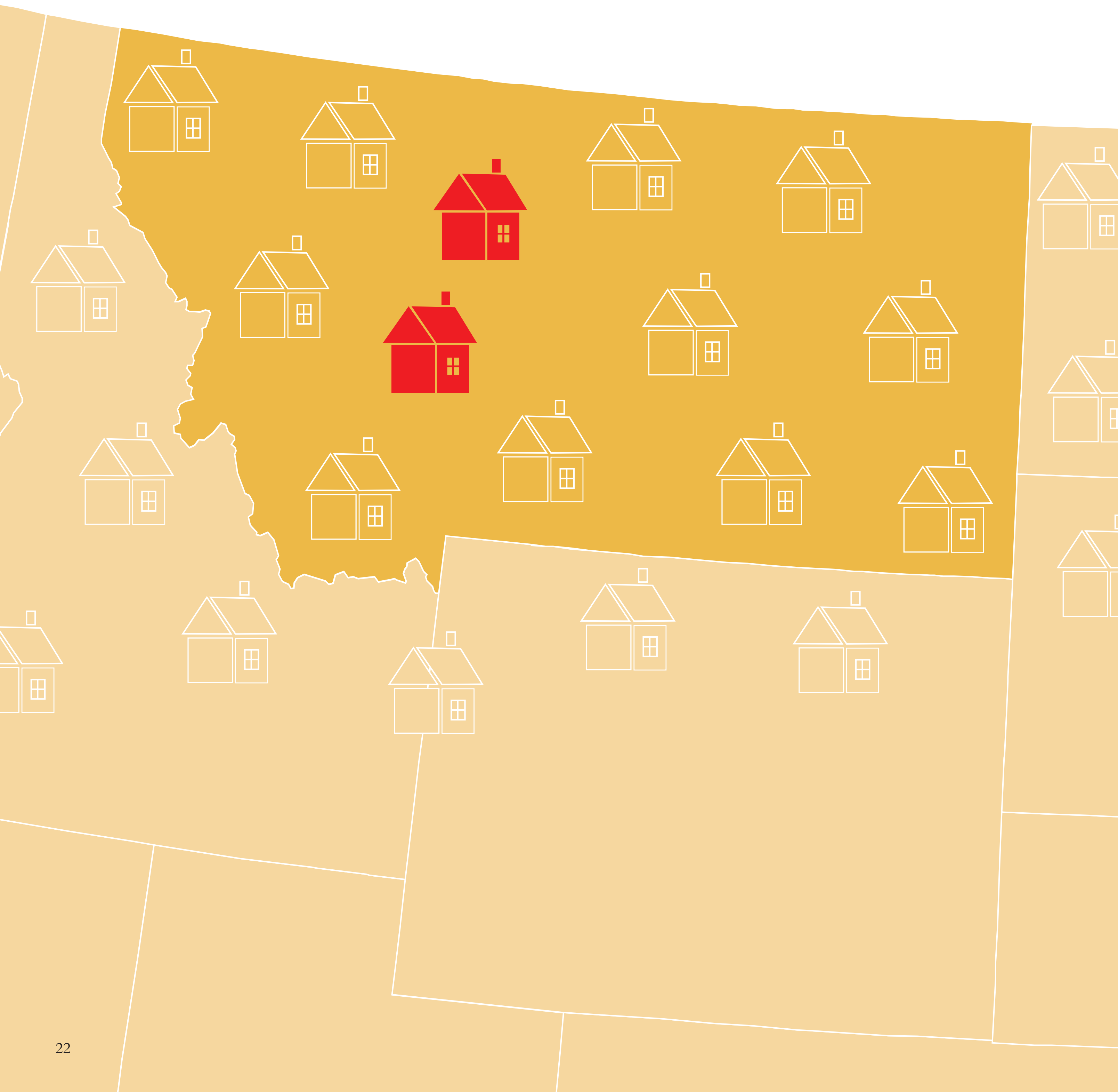
Since making the first discovery in the olfactory epithelium, Buck has unlocked the complex mapping of the olfactory balls and the olfactory cortex—at each step, placing one more piece in a larger, more complex puzzle. She's been pursuing the path of scent and perception for the past 16 years, and says she's "just scratched the surface" so far.

"That's where the joy comes from," says Buck, "and that also, I think, is where the great discoveries come from—from people who are really trying to figure out things that they don't understand. And they don't necessarily know how to do it, but they try very hard and then they succeed." ■

Meet cancer researcher Grover Bagby, marine biologist Brenda Konar, microbiologist Peter von Hippel, and nurse-scientist Jeanne Quint Benoliel in the Web exclusive.

Igniting the Spark: Another Look

The three R's—relationships, rigor, and relevance—help two Montana science teachers triumph in the difficult middle school years.



in the MIDDLE

STORY AND PHOTOS BY BRACKEN REED

EAST HELENA and GREAT FALLS, Montana—The news hasn't been good. In 1999, results of the Third International Mathematics and Science Study (TIMSS) showed U.S. eighth-graders not only lagging behind their international peers, but also scoring poorly in relation to U.S. fourth-graders. Many critics began to speak of a middle school "dip"—a downturn in student achievement that begins in the middle school years and leads to further struggles at the secondary and postsecondary levels. William H. Schmidt, a professor of education at Michigan State University and the U.S. research coordinator for TIMSS, was particularly critical, claiming that "the middle school is the crux of the whole problem and really the point where we begin to lose it." In a comment sure to raise the hackles of most middle school teachers, Schmidt called the middle grades "an intellectual wasteland" when it comes to challenging math and science curriculum.

The results of the most recent TIMSS (now called the Trends in International Mathematics and Science Study), conducted in 2003, showed some improvement in eighth-grade science scores, but U.S. students continue to trail behind their peers in most other industrial countries. Despite encouraging signs, middle schools still find themselves the focus of intense scrutiny and criticism.

Looking for Answers

Researchers, educators, and parents agree that the middle school years are a crucial time in a student's life and can often determine future academic performance. Research has shown that most students who lose interest in math and science do so at the middle school level, which is typically the first time they are exposed to higher level thinking skills and abstract concepts.

Why so many are failing to make the transition, and what can be done to improve the situation, is less conclusive. Some observers focus on the unique social and psychological needs of middle school students and our persistent inability to meet those needs. Others claim that by focusing too much on students' needs we have failed to challenge them academically. These critics often call for wholesale grade reconfiguration and the abandonment of what they see as a "warm and fuzzy," child psychology–based approach in favor of more academic rigor. Finding a balance between these two opposing viewpoints continues to be at the center of the middle school debate.

As M. Hayes Mizell, the director of the Program for Student Achievement at the Clark Foundation, observed, "People seem not to be able to hold those two concepts in their minds and in their practice simultaneously." Until we learn to do so, he implied, we will fall short of meeting either goal.

Other criticisms of the current system are less philosophical and more pragmatic. Teacher certification programs, for instance, are a frequent target. In many states, preservice programs are designed for K–8 or 6–12 certification. Few are designed to prepare teachers for the specific content knowledge and teaching strategies needed to be successful in the typical grade 6–8 middle school. As a result, middle school math and science classes are often taught by teachers with elementary certification who may be unfamiliar with the course curriculum and uncomfortable working with this challenging age group.

Meanwhile, teachers often speak of the dearth of professional development opportunities at the middle school level and of a perceived lack of respect or prestige for middle school teachers, who are often treated as somehow inferior to their high school counterparts.

High-Quality Teachers

In the midst of this soul-searching and finger pointing, one state has gained attention for its success. Every five years the National Assessment of Educational Progress (NAEP) includes a science assessment of fourth-, eighth-, and 12th-grade students. On the 2000 NAEP, the state of Montana had the highest eighth-grade science scores in the nation.

With a high poverty rate and predominantly rural population, Montana faces the same problems as many other states, including severe budget cuts and a shortage of highly qualified teachers. For Montana, however, this last concern is deceptive. If a single factor stands out as the driving force behind the state's success in middle school science, it is its wealth of dedicated and knowledgeable teachers, many of whom, paradoxically, fail to meet the federal requirements of a "highly qualified" teacher as defined by the No Child Left Behind Act (NCLB).

Alyson Mike is an eighth-grade science teacher at East Valley Middle School in East Helena. In the past three years Mike has had a flurry of recognition: In 2002 she was a Presidential Award winner; in 2003 she received one of Montana's two $25,000 Milken National Educator awards; and in 2004 she was the Montana Teacher of the Year and was awarded an I CAN Learn-NEA Foundation Award for Teaching

Beth Thomas

Excellence. Ironically, Mike would not be considered a highly qualified teacher were it not for her national board certification.

"I have a biology degree," says Mike, "but I only have minors in chemistry and physics. Under NCLB I would be considered unqualified because I don't have majors in those areas." As Mike sees it, there is a definite need for teachers with content area knowledge at the middle school level, but to say that everybody has to have a major in any field they teach is stretching the spirit of the law beyond the breaking point. "When I started out I taught biology, chemistry, physics, and sometimes earth science, too," says Mike. "Well, where are you going to find people who have four majors and then are willing to start at a $22,000-a-year job in Circle, Montana?"

Two hours to the north, at East Middle School in Great Falls, Mike's friend and colleague Beth Thomas is another example of a highly qualified teacher who challenges the literal interpretation of the term. Thomas has been teaching middle school science since 1993 and is also a Presidential Award winner and 2003 Montana Science Teacher of the Year. But, similar to Mike, she might not be considered a highly qualified teacher based solely on her educational training.

"When I went into education I was told that a general science or 'broadfield' degree was the way to go in Mon-

tana, particularly if you wanted to work in a rural setting," says Thomas. "They said that if you wanted to teach you shouldn't get too specific because you could be teaching the whole gamut, from seventh grade to high school. I still think that's very appropriate for middle school, with the integrated types of curriculum that we see."

A Shared Philosophy

What Mike and Thomas have in common goes far beyond nitpicking interpretations of the No Child Left Behind Act. The two met several years ago at a Montana Education Association conference and discovered that they shared a common approach to teaching and a similar temperament. Both are high-energy, motivated, passionate teachers who manage to find the balance that Mizell believes is missing in so many middle school educators: They challenge their students academically while also being supportive, warm, and caring adult role models for them. They love science, have a deep understanding of their curriculum, and never stop trying to find fun and engaging ways to present it to their students. At the same time, they love working with middle school students. From their first meeting, Mike and Thomas recognized these qualities in each other. As the

Alyson Mike

years have passed, they've continued to stay in contact, exchanging e-mails and meeting up at conferences, sharing lesson plans and advice.

In person, Mike and Thomas are both as different and as similar as East Helena and Great Falls. A visitor to their separate classrooms will notice subtle differences in approach, emphasis, and classroom environment, but the overwhelming impression is that their similarity as teachers extends beyond a shared philosophy and down to the nitty-gritty of everyday teaching strategies. Both are award-winning teachers for a reason. Both could, and do, serve as model teachers.

A Personal Approach

Both Thomas and Mike are adamant about taking a personal approach to teaching. As Thomas says, "With all my students, one thing I think is critical is to let them know you care about them. I try to get to know them—their interests, backgrounds, family situations. If they know you care, they will work for you and they will behave for you. It's essential to their success."

Mike admits that such a personal approach can be difficult to sustain "when you run 130 kids through your classroom everyday," but she has built in small strategies for making one-to-one connections with her students. "I try to connect with every kid, every day," she says. "I use notebooks and other things so that they have to come talk to me at least once during the class period. That way, even if it's just a 'great, now go do this' kind of thing, at least we've made a small connection. There are days that the nature of the lesson just doesn't lend itself to it, but I really try to do that every day. Otherwise there are just too many kids that get lost in the shuffle."

Another approach that both teachers are passionate about is making science relevant to their students' lives. "You've got to teach for meaning," says Thomas. "You've got to find a way to make it connect to their lives or else it's like, who cares? I wouldn't care if I didn't think something connected to my life in some meaningful way."

For Mike, this often includes drawing on the immediate surroundings. "I think a subject can be especially meaningful if you can tie it in to something local," she says. "It can be something that's going on in town or something about the local landscape." An example, she says, is the local lead smelter that until recently was the lifeblood of the East Helena community. "That's played in so well to some of things we've done," says Mike. "We've talked about the different elements and so we've talked about sodium metal, and then we've got two railroad cars of sodium metal sitting just up the road. The kids get curious, and that's what science is about: being curious about the world around you."

Encouraging curiosity is at the heart of the inquiry-based approach that both Mike and Thomas espouse. It's an approach that requires patience, they both counsel, and it does not always show immediate results on a typical standardized test. "If you're going to do true inquiry," says Mike, "you give them guidance, but you don't answer things for them. It's more like, 'Well, I don't know, see what *you* think, try it out.' Kids can get very frustrated with that. And for a teacher, it's a different way of doing things. Let's face it, most teachers like to have control, and inquiry is much less controlled, much less structured."

"It's a process," Thomas says about inquiry-based instruction. "It's something that you weave continually throughout every lesson that you teach. It doesn't always have to be a full-blown inquiry-based activity or project, although you certainly want to do those. But it's more about a continual process—continually engaging students in their own learning."

"The ultimate goal is that you create a scientifically literate group of people, right?" Mike asks rhetorically. "And the only way you do that is to have them think through ideas for themselves."

For both Mike and Thomas, the beauty of teaching middle school–age students is that their minds are still open and their curiosity and enthusiasm are still intact. "I really believe that this is an age group where you can make more impact than with any other," says Mike. "They're still at an age where they want to get excited about things and they're willing to show that. They're very curious about things."

"It's a critical time to hook them on science," Thomas agrees. "For some of them, with certain topics, you can just see the lightbulbs go on, and that's very powerful. That's what it's all about." ■

Science on ICE

Fractures in the ice at the Anvil City Science Academy pond in Nome.

A far-flung network of teachers and students helps a university researcher track lake ice and climatic change throughout Alaska

By Rhonda Barton

FAIRBANKS, Alaska—Tim Buckley totes a shotgun when he takes his ninth-grade general science students out to do fieldwork once a week in Barrow, Alaska. "I'd be a damn fool not to take a gun with me and parents would be upset," says Buckley. After all, his students are engaged in measuring lake ice and snow at Imikpuk Lake, a mere 100 meters from the Arctic Ocean and from polar bear habitat.

To the southwest, Todd Hindman's middle school students are also observing and collecting data on snow and ice. They climb aboard their snowmachines for the half-mile ride to their study site: an old gold mining dredge pond near the original claim that started Nome's gold rush back in 1899.

Far to the southeast, Marc Swanson's sixth-graders are participating in the same research project at Seward's Bear Lake. But their data look different. It turns out that Seward's milder maritime climate produces lake ice that's almost as thick as Nome's, but it grows upward instead of downward. That's because of "overflow," standing water on top of the ice that eventually freezes.

All three teachers are part of the widely scattered Alaska Lake Ice and Snow Observatory Network or ALISON. They're using their own backyard as a laboratory for rigorous scientific exploration that holds important clues to the variability of Alaska's lake ice and winter climate. From Barrow, Nome, and Seward to Poker Flat, Denali, and Shageluk, students are mastering scientific procedures and instruments to determine how much heat flows out of the state's lakes through the blanket of snow and ice. Best of all, the information they're gathering is part of a genuine research project—funded by the National Science Foundation, the International Arctic Research Center, and the University of Alaska—that could help predict the effects of future climatic change.

Photos by (left) Martin Jeffries, (right) Marc Swanson

POLAR EXPLORERS

At the hub of ALISON is Martin Jeffries, research professor of geophysics at the University of Alaska Fairbanks. Though Jeffries grew up in Northern England, he's spent most of his professional life in close encounters with glaciers, ice shelves, icebergs, and sea ice. A map of Antarctica looms above the desk in his orderly office on the UAF campus, while skinny snow probes lean like pickup sticks against the wall.

In October, just as Alaska starts to freeze up, Jeffries begins his travels to the 14 schools that comprise the ALISON network. He helps each teacher set up an observatory at a nearby lake or pond: A 100-meter line of wooden stakes, spaced every five meters, marks the sampling and measuring transect for the rest of the winter. In the months to come, teachers will visit the sites—sometimes weekly—with their students, measuring the depth of the snow, the snow density, the temperature at the bottom and top of the snow cover, and the ice thickness.

Jeffries reaches around and grabs one of the probes, demonstrating. "We have a snow probe with a metric tape on the outside—it's 1.2 meters—that gets pushed into the snow to the ice surface so you can read the snow depth," he explains. "On the bottom, in a metal tip, there's a thernistor—basically an electronic thermometer—that allows you to measure the temperature down there."

Using samples and data collected at 21 points along the transect, students calculate the temperature gradient, or the rate of change in temperature, as well as the thermal conductivity of the snow. Multiplying the two numbers gives you the conductive heat flow: the amount of heat that comes out of the ice and snow and escapes into the atmosphere. The information, meticulously entered into spreadsheets, is sent to Jeffries at the Geophysical Institute. It's checked and posted online (at www.gi.alaska.edu/alison) so all the sites can compare results.

Jeffries stresses that ALISON partners are contributing to a lake ice database that has long-term value—especially at a time when the consequences of environmental change are being observed throughout Alaska and the Arctic. "We didn't create a set of measurements just because it was something (students and teachers) could do. They really are scientifically useful," he emphasizes. "Lake ice has tended to be kind of an orphan in terms of scientific interest and support. We've set out to try to change that."

The data document how lake ice thickness is changing now; they also help researchers test computer models to predict what might happen in the future. Already the students' measurements are challenging some assumptions. So far, says Jeffries, he's seeing less variability in ice thickness around the state than he anticipated.

BUILDING ON

"It was a surprise for me and Martin how different our data were than expected," says Marc Swanson, who recently retired from Seward Elementary but remains active in the project. "We got meter-thick ice, despite Seward's warmer climate. When our kids realized they were competing with Nome and Barrow, they said, 'This is cool: We've got good ice!'"

Photo by Rhonda Barton

Martin Jeffries

Swanson wasn't content to stay within the original confines of the ALISON project. Together with Cheryl Abbott of Wasilla High School, he created an activities book that translates the central concepts of ALISON into a classroom laboratory setting. Ten activities, all linked to National Science Education Standards, explore topics from thermal resistance to latent heat, the insulating properties of various materials, and the speed of heat transfer.

In their book, Abbott and Swanson note, "ALISON allows students of all ages to better understand the concept of heat flow. Students already come into the classroom with a pretty good understanding of heat. They know if they touch something hot they'll get burned. If they touch their tongue on a metal gate post on a 'balmy' winter day in Fairbanks, they'll become quite attached to their project. They already have an intuitive understanding, and interest, in conductive heat flow."

"It is our job, as teachers, to tap into the students' interest, preexisting knowledge, and misconceptions to create a unit of study that builds on practical knowledge and moves toward conceptual and scientific understanding."

IN THE FAR, FAR NORTH

Tim Buckley has seen how ALISON engages students who otherwise might not be turned on to science. The dozen freshmen in his general science class are enrolled in basic math and identified as at risk of not passing the state's high school qualifying exam. "Rather than putting them in physical science where algebra is required—and setting them up for failure—we use general science to patch holes. It covers everything," he says.

Buckley uses ALISON as the class's annual project for the school's science fair. "The whole class collects data and keeps track throughout the year, checking Jeffries' Web site every week to see how we're doing relative to other sites," he reports. It soon becomes obvious that Barrow's rate of ice thickness is greater than everybody else's.

Just how cold does it get at the Arctic Circle? Buckley dryly notes, "Let's say if it's 20 below and not windy, it's a pretty darn nice day. We'll go out even when it's 30 below." Using grant money, Buckley purchased 18 insulated Refrigerwear suits and surplus military "bunny boots" to protect his students in the field.

Back at Barrow High, the class loads the data into computers, creates graphs, and comes up with hypotheses. Buckley says his students—70 percent of whom are Alaska Native—already can make fine distinctions in snow and ice. He tells how an Inupiat elder visited the classroom and was able to name 12 different types of ice in a single core that students had drilled. But through ALISON, their understanding expands. "My goal is to have the kids learn how to use the scientific method to solve a problem. They get a good feel for that, and the fact that it's okay to go off in one direction and then backtrack and go off in another."

HANDS-ON DISCOVERY

At Anvil City Science Academy, a charter middle school in Nome, Todd Hindman views ALISON as a great way to get parents involved. Dads who usually don't volunteer in the classroom are willing to help out, ferrying kids to the site by snowmachine or sled.

This year, Hindman is using a nearby pond to teach his fifth- through eighth-graders about the properties of water. He relates the heat of the water to how the pond freezes over and how it melts.

"Many of my kids may not understand all of the science they're doing," Hindman remarks, "but that's fine with me. What I think is important is giving the kids the opportunity to get outside the classroom and collect meaningful data that they can easily see is being used by a science researcher, who obviously enjoys the work he's doing and working with them. It's been a great experience for the kids, myself, and Martin as well."

A HELPING HAND

ALISON teachers agree that one of the main reasons the project works so well is Jeffries' "inquisitive nature" and his strong desire to help K–12 teachers bring polar science into the classroom. Besides visiting the sites and personally engaging in scientific inquiry with network partners, Jeffries gathers the teachers together at the end of the school year for a five-day workshop in Fairbanks. Attending these sessions and sharing data throughout the school year forges a professional learning community and helps reduce the isolation that educators in remote areas can sometimes feel.

"The teachers really seem to appreciate they're working with a university scientist," says Jeffries. "Some of the feedback we're getting [shows] it's certainly helping them with their science and their confidence. The fact that someone is providing them with activities and materials and encouragement seems to make a difference."

When you're checking your back for polar bears, braving temperatures that dip well below freezing, and maneuvering around snow drifts, it also makes a difference to know you're pursuing an important scientific mission. Students can warm themselves with the realization that they're helping to fill in important gaps in our understanding of the rapidly changing Arctic environment. ■

COLLABORATIONS

Three of the ALISON teachers—Cheryl Abbott, Marc Swanson, and Todd Hindman—received a $10,000 Toyota Tapestry grant last year to further develop collaborative lake ice activities among their schools. Abbott and Swanson will report on "Project Sikuvik" (Inupiaq for "ice time") at the National Science Teachers Association convention in Dallas in March 2005.

Abbott realizes that teachers in the lower 48 might not be able to investigate ice and snow, but the bigger lesson is that "forming a partnership with a research scientist is so valuable and the motivation for the kids is so important." Abbott says all she has to do is remind her class that Jeffries is counting on them. "There's validation in that; they don't want to just write down anything and send him information that could be faulty."

In partnering with a scientific researcher, there are a few things to keep in mind:

- For the project to be successful, there must be real buy-in from the scientist.
- Measurements have to be meaningful to the students; they can't be so sophisticated that kids don't understand the numbers.
- It helps if the project relates to core scientific phenomena that the teacher has to cover as part of the curriculum.
- "Money is good," Swanson, Abbott, and Hindman agree. Getting funds or in-kind contributions of equipment and materials to support the project helps a lot in these days of tight budgets.

Building a Legacy,

ONE TEACHER AT A TIME

STORY AND PHOTOS BY BRACKEN REED

RICHLAND, Washington—One by one the teachers and scientists begin to arrive, driving in from the south on the wide, sycamore-lined streets, past the manicured lawns and industrial office buildings of the Pacific Northwest National Laboratory (PNNL) campus. A few of the teachers miss the turn, pass by, circle back, squinting in the early morning sunlight, looking for the designated building.

PNNL is operated by the Battelle Corporation for the U.S. Department of Energy. Designed in the 1960s, the campus is all right angles and functional efficiency, with an earth-toned sameness to its buildings. For those who don't work here every day, it's easy to get lost.

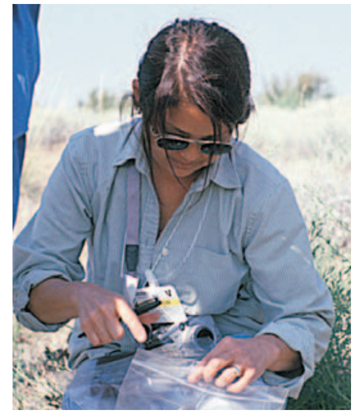
At this early hour, most Battelle employees have yet to arrive, and rush hour has yet to begin in earnest for those heading farther north, out to what the locals call "the area": the old reactors, laboratories, processing facilities, and storage tanks scattered across the 560-plus square miles of the Hanford Nuclear Reservation. An eerie quiet hangs over the stark landscape, broken only by the random calls of songbirds. There is a sense of life going on in the morning shadows, of coyotes moving swiftly through the sagebrush, just out of sight.

Many have called this area a wasteland—empty, desolate, barren—and its status as one of the most toxic, radioactive spots in the country might bear them out. But those who take the time can find another reality here: a landscape teeming with wildlife and rare plant species; the last free-flowing stretch of the Columbia, one of the West's greatest rivers; petroglyphs and ancient village sites; and the largest remaining area of the shrub-steppe ecosystem that once flourished in the Columbia River Basin.

One of the great ironies of Hanford's nearly half-century role as part of the nation's nuclear defense program is that much of the site remained virtually untouched—used mainly as a buffer zone around the main reactor areas. As a result, while crews continue to clean up what the U.S. Department of Energy likes to call "legacy waste," others have been working hard to create another, parallel legacy: to save the untouched areas from development; to draw public awareness to their beauty and ecological importance; and to use them as a model for returning some of the disturbed areas to a semblance of their original glory.

On this summer morning the PNNL campus is the meeting ground of an unlikely group: 20 elementary and middle school teachers, a handful of Battelle scientists, and a program manager, Karen Wieda, who is already moving at full speed. Tall and thin, with the tanned, healthy look of one who spends a lot of time outdoors, Wieda is obviously in her element. She waves down those who mistakenly pass by the parking lot of the Sigma V building, greets each new arrival with an easy familiarity, and keeps things moving without once seeming to be in a hurry. "Has everybody got sunscreen?" she asks. "Hats? Water bottles? Notebooks?"

July in the semiarid country of Eastern Washington can be physically withering, with temperatures often topping 100 degrees in the afternoon. An early start to a field trip is the best antidote to fatigue, dehydration, and sunstroke, as Wieda well knows. She quickly marshals the group toward three



waiting vehicles, and within minutes they are on the road, passing through the north end of the PNNL campus and onto the main road of the nuclear reservation.

Every July for nearly a decade, Wieda has directed the Partnership for Arid Lands Stewardship (or PALS)—a field-based, professional development project that matches K–8 teachers with Battelle scientists. The program recruits local teachers who are already part of Battelle's larger educational project—Leadership and Assistance for Science Education Reform (LASER)—and are using one of its recommended science kits in their classrooms. For two weeks teachers are immersed in the world of science and in the ecology of the Columbia Basin.

The program is based on a set of underlying principles that some may find radical: that to learn about science, teachers need to occasionally have contact with actual scientists; that the places we live, the landscapes that surround us every day, are the most enlightening, effective, and inspiring instructional "tools" that exist; and that science, far from being a luxury or secondary subject, should be an essential, core subject at both the elementary and middle school levels.

CONNECTING SCIENCE TO THE REAL WORLD

Every year, PALS is organized around a practical, real-world scenario. This year, the scenario could hardly be more up-to-the-minute. In June 2000, then-President Bill Clinton designated significant areas of the Hanford Nuclear Reservation, as well as 57,000 federally owned acres to its north, as a national monument. The Act transferred control of these areas from the U.S. Department of Energy to the U.S. Fish and Wildlife Service, and created the 195,000-acre Hanford Reach National Monument. While not popular with everyone—especially those hoping for more local control and for agricultural and industrial development—the move served as a kind of marker between the old Hanford and the new. It was the end of one era, and the beginning of another one.

Within two years, plans were under way to expand an already existing museum, called the Columbia River Exhibition of History, Science, and Technology (CREHST), and to create a Hanford Reach National Monument Interpretive Center on land just south of the city on the west bank of the Columbia River. The area, called Columbia Point, or simply "the Point" in local parlance, is at the confluence of the Columbia and Yakima Rivers, and has great cultural significance for area tribes. But while it is considered a sacred place by many, it is also a highly disturbed area, popular for many years with off-road motorists, anglers, illegal dumpers, and underage drinkers. Before the interpretive center can be built, which is slated to begin in 2005, the area requires significant study and rehabilitation.

This became the basis for the PALS scenario: The teachers are to imagine that they're a group of scientists working for a consulting group. They must study the area and make recommendations for addressing cultural concerns, restoring the natural habitat of the area, and building the center without causing further disturbance. As these would-be scientists go about their two-week study, actual scientists are at work on a real study that only differs in its breadth and depth. It's about as relevant and "close to home" as a science project could be.

INTO THE FIELD

The convoy of Battelle vehicles turns right onto a dirt road and heads toward the river. Since leaving the Sigma V parking lot, Wieda and one of the participating scientists, a retired biologist named Bill Rickard, have been keeping up a constant, informative patter. Rickard first joined Battelle in 1965 and his knowledge of Hanford and the entire Columbia Basin is encyclopedic. With his white hair, baseball cap, blue jeans, and casual demeanor he gives an impression that is both grandfatherly and eternally youthful. He wears his knowledge lightly, never becoming the boring "dad" who lectures about local history, while the "kids" in the back of the car roll their eyes and wonder how much longer the trip will take. His comments are seemingly offhand, spoken in a quiet drawl, almost as if to himself. "Mulberry trees," he says, looking out the window, but not pointing. Beside him, Wieda serves as a kind of foil, peppering him with questions, coax-

ing him to expand on his sometimes droll comments. There is a remarkable timing between the two of them, a kind of seamless back and forth interplay that is obviously based on mutual respect, a shared love for the environment, and contrasting but compatible temperaments.

"Those mulberry trees aren't native," Wieda says in a half-statement, half-question, leaving the door open on a subject she knows inside and out.

"No," replies Rickard, still looking dreamily out the window, his hands folded in his lap. "They escaped. They were brought in by farmers and they self-established."

As the car bumps down the dirt road, the conversation spools out in this casual way. Before they realize it, the teachers have probably learned that farming first began in the area around 1903; that the farmers were displaced during World War II, when the government turned the area into the Hanford Nuclear Site; that many of their orchards and windbreak trees still dot the area; that black cottonwoods are the only native trees along this stretch of the Columbia; and that Lewis and Clark camped downriver from here and wrote in their journals about the lack of trees—perhaps a subtle suggestion that the teachers should be writing some of this seemingly idle conversation down in their journals.

"Silkworms eat mulberries," Rickard says to no one in particular, wrapping up this line of conversation.

The convoy pulls up beside the river—the drivers taking care that the hot undersides of the vehicles aren't parked directly over potentially fire-starting underbrush—and the scientists and teachers pile out. Wieda gives the teachers a preview of the day's activities and their purpose within the overall project. After a typically informal lecture by Rickard about the specific area in which they are standing—and a reminder to watch out for snakes, scorpions, and black widows—the teachers break into teams.

This is another consistent strategy of the PALS project. Each year the teachers are divided into three groups that broadly represent the work of actual scientists. Each team—the terrestrial, the geologic, and the aquatic—is led by a Battelle scientist who is a specialist in that field. Rickard and Janelle Downs take the terrestrial team, Duane Horton, the geologic team, and Ted Poston and Sue Sargeant, the aquatic team. Wieda jumps from group to group, keeping things on schedule and providing support. All the scientists, along with Shannon Goodwin who didn't make today's trip, have been involved with PALS for several years.

The teachers have already visited the Columbia Point site, where they took soil and water samples and looked closely at the features of a disturbed habitat. Today's goal is to study a habitat that, in contrast, is about as close to pristine as can be found. To facilitate this, each team heads for a different part of the designated area and begins to build transects. Using a measuring tape, string, stakes, a hula hoop, and other tools, each group creates a 100-square-meter plot. After setting certain parameters, such as the minimum height of plants to be counted, they begin to note each plant within the transect. It's here that the real fun begins.

The names of the plants flow like music from the mouths of teachers and scientists alike: stork's bill, burr sage, bitterbrush, and fiddleneck tarweed. Bunchgrass, sagebrush, prickly pear, and turpentine parsley. Purple aster, needle and thread grass, and snow buckwheat. It's a sacred choir.

Meanwhile, geologic team members are sifting the soil within their transect. Medium sand, coarse sand, silt, sandy clay loam, and animal scat, goes the song here. "How much of that is there?" asks Horton. "Is it a trace?" The teachers are on their hands and knees, sifting and grading the soil with the fervor of lifelong specialists. "Let's just say trace," Horton directs. "We're overgrading again."

As the day progresses, the teachers will visit several other sites. They'll eat lunch beside the old Hanford townsite while grasshoppers chirp wildly in the brush. They'll see the stumps of an old apricot orchard still standing in neat rows. They'll look out across the river at the chalky White Bluffs that loom over this free-flowing stretch of the Columbia. They'll see pelicans, kestrels, and greater egrets. They'll hear the distinctive songs of meadowlarks, horned larks, and lark sparrows. They'll watch a bright green praying mantis cling to a slender plant. They'll learn about soil types, plant species, and the meaning of words like "eolian" and "fluvial." And this is only the third day.

By the end of the two weeks, the teachers will give presentations on their mock-proposals for the restoration of Columbia Point and the building of the interpretive center. They'll develop strategies to integrate this kind of ecological study into their instruction, how to access resources that can support such activities, and how to share what they've learned with their fellow teachers. But most important, they'll learn something about the power that comes with fully investing yourself in the place where you live. It's this kind of knowledge that can lead us away from a legacy of waste, toward one of stewardship. ■

In the Lab, Discovering the "REaL" World

Through a Wilderness

THE NATION'S LONGEST-RUNNING OUTDOOR SCHOOL OPENS EYES AND MINDS THROUGH EXPERIENTIAL LEARNING IN A MAGICAL SETTING.

By Rhonda Barton

WEMME, Oregon—The stillness of the Mt. Hood National Forest is broken by birdsong and the distant rise and fall of children's voices. As you thread your way through old growth Douglas fir, your footsteps muffled by the thick carpet of decomposing leaves, you're as likely to chance upon a skittish fawn as a knot of squirrelly sixth-graders. Scurrying like termites over a rotted stump, the boys and girls might be dipping into a fast-flowing stream for water samples, gathering spores, or peering underfoot for bear scat.

Just as Oregon students have been doing for almost 40 years, these elementary and middle schoolers are repeating a ritual that takes place every fall and spring: spending six days camping in rustic cabins; learning firsthand about animal and plant life, rivers and forest ecosystems; and making self-discoveries along the way.

Surviving Hard Times

Founded in 1965 with a federal grant, Multnomah Educational Service District's Outdoor School has survived on local and state tax dollars and sheer determination. When the financially hard-pressed Portland Public Schools decided to cut Outdoor School from its spring 2003 curriculum—threatening the whole program—volunteers went into overdrive. In six weeks, former campers and parents of current ones raised a half-million dollars to restore the session. The following fall, Multnomah County voters approved a temporary income tax that filled school district coffers and granted Outdoor School another reprieve—at least until June 2006.

A newly revitalized nonprofit group, Friends of Outdoor School, is working to secure future funding from foundations, corporations, and private donors. In the meantime, though, far from the hubbub of ESD offices, the traditions of Outdoor School continue to be handed down to a new generation of campers.


Photo by Patricia Cordell

"The clearest way into the universe is through a forest wilderness."
—John Muir

Leaving Behind the Familiar

The yellow buses pull into Arrah Wanna on Sunday, one of five camp facilities that the ESD leases from religious and service organizations. Kids from eight different school districts—many of whom have never been away from their families or even their neighborhoods—tumble out into a totally different world than the one they left behind.

For the next six days they'll follow a strictly structured schedule that starts with a 6:45 a.m. wake-up call and goes full tilt until the embers of the nightly campfire die out and lights are snapped off at 9:15 p.m. There are no televisions, computers, Game Boys, or CD players to distract these preteens and disturb the tranquillity of the forest. The four walls of the classroom are replaced with endless sky, open meadows, and thickets of fir and alder. Even gym takes on a different flavor: An exercise routine is transformed into "fungus aerobics" with kids breathlessly calling out "cap-gills-ring-stem-mycelium" as they pound out jumping jacks and touch their toes.

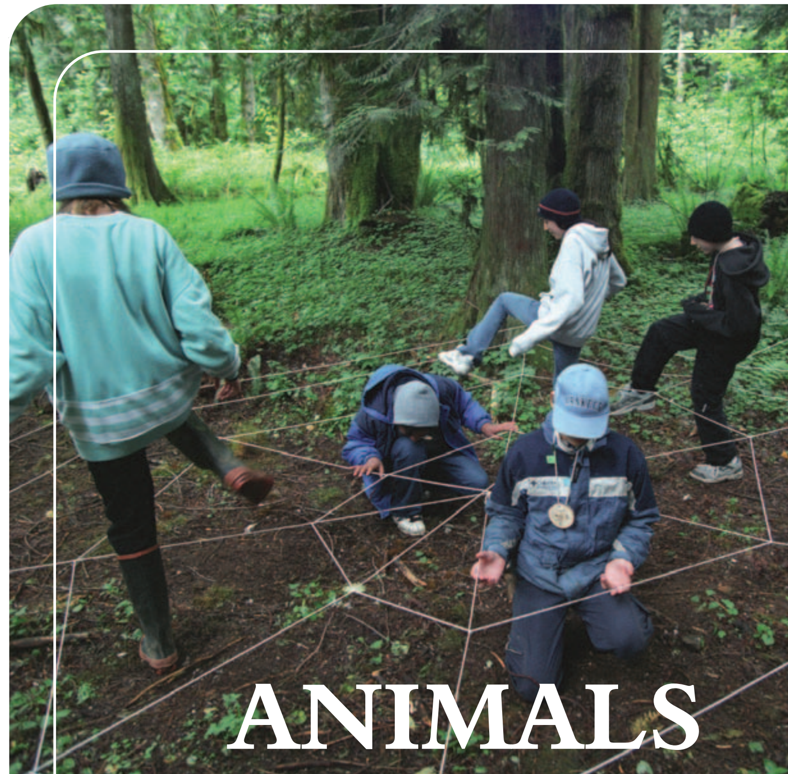
In between family-style meals, class meetings, and chores like cabin cleanup, students delve into intensive, hands-on field studies that focus on four key elements of the environment: water, soils, plants, and animals. Most of the activities, which are aligned with Oregon's eighth-grade benchmarks, are learned and then taught by high school volunteers. Some are taught by staff members with high school students assisting. All are so absorbing that students barely notice that they're learning hard-core science like the relationship between soil pH and plant growth or how stream turbidity affects sediment, water quality, and aquatic life.

In a state where environmental agendas often clash with bread-and-butter economic issues, the Outdoor School tries to veer away from a single political viewpoint. "We don't want to offend any families," says Camp Arrah Wanna Director Andrea Hussey. "We can't say things like 'logging is terrible' because there are students whose parents are loggers. So, we're very careful with our politics. What Outdoor School really does is create a sense of reverence for the natural world. … It opens their eyes to what's out there and they take some of that back to their communities."

Life Lessons

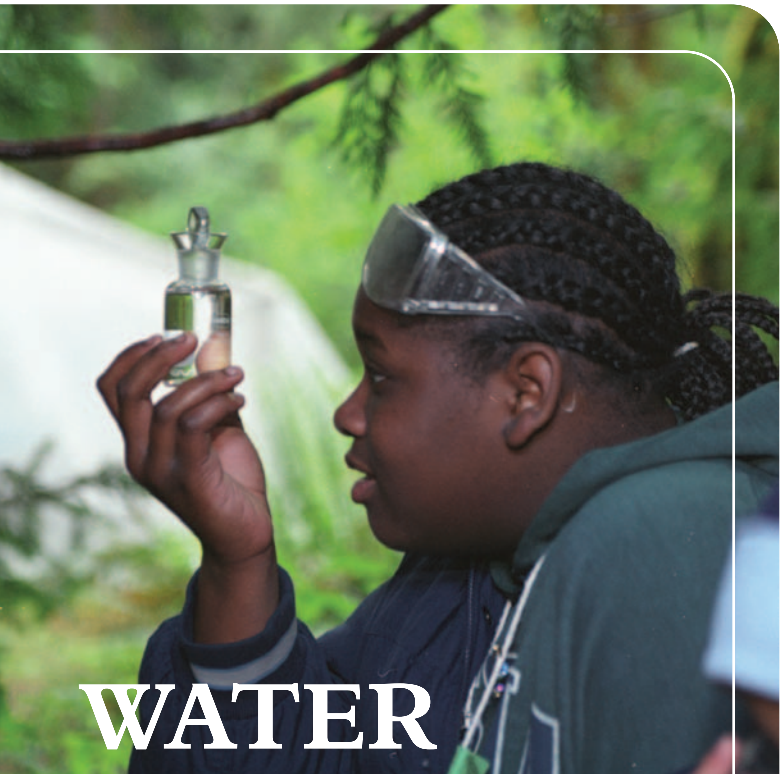
For many kids, the most important lessons have to do with finding their own place in the world. "Whenever kids experience disequilibrium they're learning," points out Lory Lauridsen, a Gilbert Park Elementary School teacher. "My kids come knowing a lot of the science, but they're learning who they are, what they can do without Mom and Dad, and that's powerful. For teachers, (Outdoor School) shakes up your stereotypes about students—which is always a good thing."

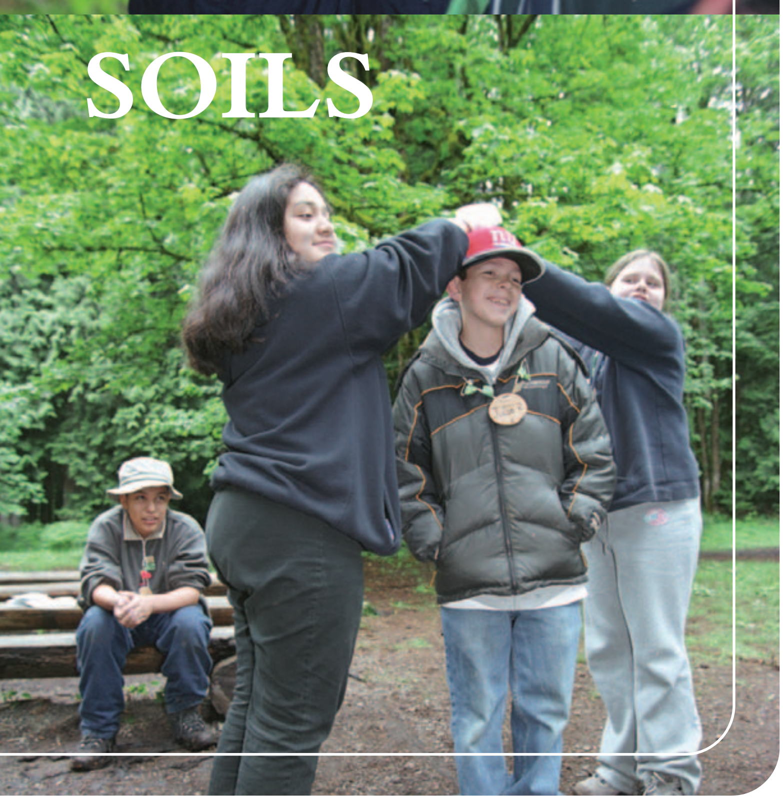
"The learning that happens here is phenomenal," adds Sherry Russo-Card, a teacher from Mt. Tabor Middle School. "We come back with a great sense of community.



ANIMALS—One student plays the spider, while the rest of the group tiptoes through a web, trying not to set off vibrations and get "caught."

PLANTS—Using geometric triangulation and forestry tools, campers calculate the height of a tree and the volume of lumber it contains.





Photos by Patricia Cordell

WATER—Students test the temperature and dissolved oxygen level of water taken from the nearby Salmon River.

SOILS—Even geologic history can be creative: The kids act out exploding volcanoes and flowing lava.

Facts and Figures

Number of students served each year: 7,000

Cost per student for one week: $267

Number of high school volunteers at the spring session: 1,003

Number of eggs consumed during the spring session: 41,940

Number of school buses used to transport sixth-grade classes and student leaders to the spring session: 392

Why sixth-graders? "Kids are young enough that they still can be kids, but they've started to develop their personalities and become young adults. It's a great age, right on the cusp where everything starts to change for them," says Andrea Hussey, Camp Arrah Wanna director.

For information on Outdoor School and other MESD environmental programs: www.mesd.k12.or.us

For Friends of Outdoor School: www.passonthememory.org

Students relax and you form a whole new relationship with them because they see you as a person, not just an authority figure."

Russo-Card's students reflect on the experience when they return to the classroom, publishing a newsletter that encapsulates what may be the most remarkable adventure of their entire school career. Here's what they'll remember:

- "Soil field study is really fun. Students get to do critter catch, make mud farms, make a mountain out of mud, look at a rock collection, and soil compaction. It is good to remember not to call the soil 'dirt' during the field study because the leaders would get mad when they heard this. They will always correct you, 'Dirt is only misplaced soil!'" *—Michael*
- "Letter writing is good if you are really homesick. It really does help. You can write to anyone you want to, even your pets." *—Jenna and Kaela*
- "Water field study is one of the best field studies ever, because you get to be by the water. You get to see if the water is polluted or not by catching intolerant and tolerant bugs. Another thing you get to do is test the water to see if it is acid, alkaline, or neutral. We found out that the Salmon River was neutral. Since the water was neutral, all kinds of creatures could live (there)." *—April and Vienna*
- "Having to live in a cabin for one week was really different, sleeping in a bunk bed instead of your own. If you were on the bottom you could always hear the person

above you. Being on top, you had no head board. I almost fell off the top bunk. … Living with your cabin buddies was not always easy when they did not follow the rules. For one week your cabin was your family. You worked as a team for the time." *—Sharie*

- "To be chosen for the tree planting ceremony (on the last night of camp), someone must be an outstanding student during field studies. … The field study staff begins with a few words. Then the tree ceremony participants walk up behind a baby tree, which symbolizes growth in friendship. Soil, which is collected by every student at Outdoor School (and brought to camp from a 'special place' at home), is then placed in the hole around the tree. This is to show that there is at least one place on the Earth we all have a connection. A snail is placed next to the tree and water is poured over it so it can be healthy. Those involved in the planting also state their name, what school they go to, and their favorite thing about Outdoor School. When I (Allison) did this I started to cry, because Outdoor School is so special." *—Abby and Allison*

For Abby and Allison and an "alumni" group that now numbers more than 275,000, the memories of Outdoor School—the silly songs, cold showers, fresh-baked snickerdoodles, nature hikes, cool counselors, and hours spent crouching beside the river—will linger on, long after the other lessons of sixth grade fade like distant stars. ■

Bringing Out the Best

By Drew Peterson, High School Student Leader

Hui was the smallest of the sixth-graders in my cabin, and his high-pitched and heavily accented voice made him a prime target of ridicule. His teacher warned me that he was the most likely to try to bend the rules. The tone of the teacher's voice and the worry etched into his brow alerted me to the biggest challenge he believed that this week of Outdoor School would present.

Hui grew up in a low-income neighborhood that my family and I had lived in during part of my childhood. His middle school had been closed down one year before due to air quality concerns that lingered unaddressed for years. Not surprisingly, the school served mostly students of color. Because of this, I was ecstatic to see the week of Outdoor School evolve into something extraordinary for Hui. More than in any previous volunteer experience involving kids, I was truly able to connect with this sixth-grader. The personal "good nights" I gave each student at bedtime were the first, Hui reluctantly told me, he had ever received. He also shared with me that he now wanted to be a Student Leader in high school—perhaps this was part of the reason.

Halfway through the week, after saying our good nights, I stepped out of the cabin into the fresh forest air. Closing my eyes, I could again hear all the laughter and good cheer of the students during our activities that day. My reflection came to an abrupt halt, however, as I suddenly noticed the complete silence of my cabin behind me. My ears detected no trace of the whispering, fooling, or running around so typical of sixth-graders. Perhaps the skeptics were right. Maybe Hui and his cabinmates were strategically holding themselves back, waiting for the coast to clear. Eventually I heard a noise escaping from the window. It was Hui, whose safe, calm snoring I recognized as it tiptoed through the night air toward me.

It was not my first time as a Student Leader, and I had seen before how Outdoor School brings the best out of the "worst." But something was different this time. At the end of the week, I could not help but laugh as I tried to convince Hui's shocked teacher of the remarkable week I saw him experience—that we experienced. Perhaps what made Hui different from the countless undiscovered treasures of Outdoor School was what we had in common. That cold, calm night in the woods, Hui reminded me of another curious sixth-grader who knew he wanted to come back five years later. I was reminded of myself.

Drew Peterson wrote about Hui as his "most unforgettable character" for a college application essay last year. Drew, a three-time volunteer at Outdoor School, is now a freshman studying biology and math at Stanford University.

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." ■

Josh Ziady looks like an indie rock musician, which isn't surprising because that's what he did before trading his bass and his "day job" as a cook for a classroom gig. The 33-year-old Ziady is in his second year as a science teacher at Roosevelt High, one of Portland's most diverse schools where students speak 20 different languages. Roosevelt also bears the label of a "failing" school after four years of not making adequate yearly progress. The 825-student high school—which is roughly one-quarter African American and one-quarter Hispanic—broke into small schools this year. Ziady teaches in the Spanish-English International School, where students divide their time between Spanish language arts classes and core subjects taught in English. In a conversation with *Northwest Education* Editor Rhonda Barton, he reflects on what it's like to be a beginning teacher at a school with multiple challenges.

Photo by Michael Heavener

A Teacher's Voice: From the Kitchen to the Classroom *By Josh Ziady*

You walk into a restaurant kitchen as a line cook—like I did—with a high-powered bachelor's degree from a prestigious liberal arts college, and you're next to some guy who dropped out of high school when he was 15 and some other guy who might have been a physics professor and another guy who might be an ex-con. You have to figure out how to make burritos with these people, so you have to relate to them—no matter who they are. … That kind of prepared me for dealing with kids because there's a lot of that immediacy. You need them to do something or stop doing something. You want them to understand what you need and you have to understand what they need—and you've got to get that interaction done quickly or else you're doomed.

Nine years after graduating from Oberlin, I went to Portland State University, got my master's, and was certificated in biology and integrated science. Besides three classes of biology, I teach an interdisciplinary senior inquiry class with an English teacher. It meets twice a week for three hours and the kids also go to Portland State once a week for two hours (where they earn 15 college credits and take care of their freshman inquiry requirement).

The theme of the course is metamorphosis—we study change. It's the best class to teach because the sky is the limit, as long as we stay within the university study guidelines and the senior English standards. We split it into three sections: personal change, social change, and broad-spectrum change like how the earth has changed and how humanity has evolved. So, for example, we read *A Place to Stand* by Jimmy Santiago Baca. It's about a guy who had a tough time growing up, went to jail, and now he's a famous poet. At the same time, we studied crime in Oregon and recent research in teen brain development and decisionmaking processes. We blended all that together.

The one thing that drives me crazy about teaching is that there's no guaranteed output. No matter how hard you work, sometimes there are still kids who aren't succeeding. You try to do everything you can for them and you still have a certain percentage of your kids who aren't getting there. That's tough—especially at a school like Roosevelt, which in the last few years has gone through some really hard times and where it's not uncommon for a significant proportion of kids to not meet the state standards. You work and work and work—and so do your colleagues—and you don't get results. It's also hard to see kids in difficult circumstances that are beyond your control.

Ultimately I want my kids to think like scientists: to be able to look at something in the world, ask questions, make a prediction to answer their questions, devise an experiment to test their hypothesis, and accurately interpret their results. Realistically I don't know how many will get that, but I hope they'll get the seeds of knowing there's this process of accumulating knowledge and evaluating information. So, if someone says to them some day that you have to vote on patenting genes, they'll know what a gene is and they can think about whether that's a good idea. Should Monsanto be able to patent my genes? My goal is to instill that type of scientific literacy. ■

RESEARCH BRIEF

Launching Science Education Into the 21st Century *By Rhonda Barton*

A 184-pound metal ball named Sputnik changed the course of science education in the United States almost a half-century ago. When the Russians successfully launched the world's first satellite in 1957, it served as a flaming wake-up call—speeding by at 18,000 miles an hour. America was losing the race for space, and if we didn't step up our science and technology efforts, we literally would be left earthbound.

The nation was galvanized, a new emphasis was placed on science, and a mere dozen years later, Americans left their footprints on the moon. However, that single-minded push wasn't sustained and the trajectory of U.S. students' science performance faltered.

The latest Trends in International Mathematics and Science Study (or TIMSS), released in December 2004, shows that U.S. eighth-graders scored better in science in 2003 than in 1999, but still lag behind their peers in a number of other industrial countries. Scores for fourth-graders, who also rank behind their peers, declined over the four-year period. Of the 45 countries participating in the eighth-grade survey, the United States placed ninth; among 25 countries reporting fourth-grade results, the U.S. took sixth place.

Another international survey, the Program for International Student Assessment (or PISA), targets 15-year-old students and measures how well they apply knowledge to real-life problems. According to PISA, the U.S. ranks about in the middle of the pack in scientific literacy—scoring higher than seven industrialized nations and lower than seven others.

Perhaps a more depressing picture of the state of science achievement is yielded by numbers from the National Assessment of Educational Progress. According to NAEP, 29 percent of fourth-graders scored at or above the proficient level in science assessments in 2000; eighth-grade scores were only slightly better at 32 percent; and 12th-graders had a dismal showing at 18 percent.

Reflecting on such standings, the National Commission on Mathematics and Scientific Teaching for the 21st Century said that students' science preparation was "in a word, unacceptable." In its 2000 report, the commission—chaired by former astronaut and Ohio Senator John Glenn—called for a more rigorous curriculum, focused professional development, and above all, more highly qualified teachers. "[B]etter teaching is the lever for change," said the commission, observing that 56 percent of high school students taking physical science are taught by out-of-field teachers and nearly one in five high school science teachers lack even a minor in their main teaching field.

ON NCLB'S RADAR

The No Child Behind Act, which requires Title I schools to provide instruction by highly qualified staff, will extend to science education during the next school year. All states must develop science standards by 2005–2006 and must administer annual science assessments at least once in three different grade spans (3–5, 6–9, and 10–12) by 2007–2008. Although the stakes aren't as high as for reading and math—science scores won't be linked to adequate yearly progress—the new mandates are adding immediacy to the debate over what constitutes good science education.

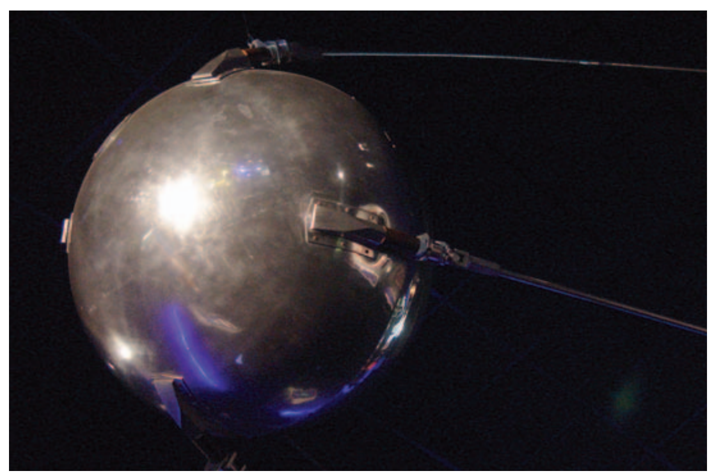


Photo © Terry Healy

To date, there's no single, research-based answer to that question. As then-Secretary of Education Rod Paige pointed out at the first Secretary's Summit on Science in March 2004, "Much more high-quality research is needed to determine what methods, resources, and curricula are best for educating students at all grade levels." While progress has been made, Paige remarked that "for the most part, we're still blindfolded and trying to find our way through a cluttered room."

The National Research Council (NRC), a branch of the National Academies chartered by Congress, is in the midst of three studies that should shed more light on the subject. One project—targeting kindergarten through eighth-grade students—is culling research from a variety of fields on how science is learned and what are the critical stages in children's development of scientific concepts. A second project aims at providing practical advice on designing tests that tap into what students really know about science. And the third NRC project focuses on the role of high school science laboratories in promoting teaching and learning.

Some educators have expressed concern that in the rush to meet national standards, schools are cutting back on the total amount of time devoted to studying science and they're replacing laboratory experiments and other forms of inquiry-based instruction with rote memorization. This is despite the fact that inquiry science—which involves activities and skills that focus on the active search for knowledge or understanding—has been endorsed by both the NRC and the American Association for the Advancement of Science. Writing in *Phi Delta Kappan* (April 2002), Olaf Jorgenson and Rick Vanosdall of the Mesa (Arizona) Unified School District state, "Ironically, even as inquiry methods and science resource centers stand poised to reinvigorate K–12 science education in America, the national movement emphasizing reading, writing, and mathematics instruction, as measured by high-stakes standardized tests, threatens to suppress the effort to make truly revolutionary progress in science education."

The authors go on to cite two Wisconsin studies and one in the El Centro (California) School District that linked improvements in science achievement scores to inquiry-based science instruction. In the case of El Centro—a high-poverty district with a high enrollment of minority youngsters—science scores among fourth- and sixth-graders improved the longer they were taught using inquiry methods. Jorgenson and Vanosdall note that the students also showed "impressive improvements" in writing proficiency and SAT-9 mathematics and reading scores.

A more recent study of an inquiry science program for low-income urban youth tracked 8,000 middle grade students in Detroit for three years. As reported in the November 2004 issue of the *Journal of Research in Science Teaching,* the study showed statistically significant increases on curriculum-based tests for each year of participation. Ronald Marx and coauthors report, "The findings indicate that students who historically are low achievers in science can succeed in standards-based, inquiry science when curriculum is carefully developed and aligned with professional development and district policies."

COMPETING APPROACHES

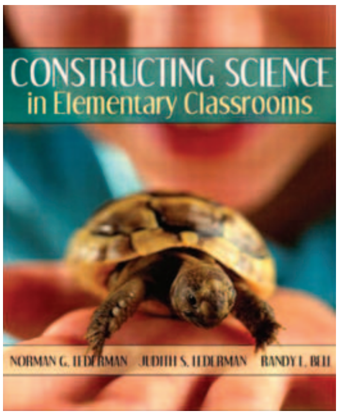
Inquiry methods are eschewed by proponents of "direct instruction" who believe that highly prescribed curricula and classroom procedures are more effective in science education. The National Institute for Direct Instruction, based in Eugene, Oregon, weaves science content into its primary grade reading materials and provides videodiscs for middle and high school science classes. Administrative Director Kurt Engelman expects the coming NCLB science requirements to prompt more queries about the institute's science products.

Direct instruction advocates have been buoyed by recent research by David Klahr, a psychology professor at Carnegie Mellon University. Klahr and his colleague, Milena Nigam, studied more than 100 third- and fourth-graders who were asked to devise experiments with balls and ramps of different sizes and materials. The children were randomly assigned to two different groups. In the direct instruction group, students watched teachers conduct experiments and explain principles before attempting experiments on their own. In the discovery learning group, children designed experiments with only a minimum of teacher intervention. As reported in *Psychological Science* (October 2004), students in the direct instruction group performed better, on average, than those in the discovery group. They were also better able to transfer their knowledge to a new situation at a later date.

While Klahr's results are getting widespread attention, other researchers note that the study exaggerated the teaching methods that were tested: Rarely is totally unguided inquiry or discovery used in the classroom. Even Klahr himself told *Education Week* (November 10, 2004) that while complicated science lessons often call for a more direct approach, teachers should avoid strict adherence to one method or the other. Rather, he said, "It depends on what's being taught." Klahr and Nigam have called for additional research to "generate an empirically sound basis for determining the most effective matches between topic, student, and type of pedagogy."

As the argument over how to teach science goes on—whether it's steeped in inquiry or direct instruction or a combination of both—no one is questioning the critical role that science will play in the 21st century. At the March science summit, Secretary Paige acknowledged that America's response to Sputnik in 1957 paved the way to putting a man on the moon and shaped today's world. "Now," he said, "we must prepare a new generation to choose its destiny. We do so knowing that education is emancipation, and science the source of dreams." ■

RESOURCES



Following is a list of recent research-based books and important national organizations.

Constructing Science in Elementary Classrooms, by Norman G. Lederman, Judith S. Lederman, & Randy L. Bell (Boston, MA: Allyn & Bacon, 2004).

Developing Inquiry-Based Science Materials: A Guide for Educators, by Herbert D. Thier with Bennett Daviss (New York, NY: Teachers College Press, 2001).

Discovering Elementary Science: Method, Content, and Problem-Solving Activities (3rd ed.), by Marvin N. Tolman (Boston, MA: Allyn & Bacon, 2002).

Good Practice in Science Teaching: What Research Has To Say, edited by Martin Monk & Jonathan Osborne (Philadelphia, PA: Open University Press, 2000).

Inquire Within: Implementing Inquiry-Based Science Standards, by Douglas Llewellyn (Thousand Oaks, CA: Corwin Press, 2002).

Inquiry and the National Science Education Standards: A Guide for Teaching and Learning, edited by Steve Olson & Susan Loucks-Horsley (Washington, DC: National Academy Press, 2000).

Internet Environments for Science Education, edited by Marcia C. Linn, Elizabeth A. Davis, & Philip Bell (Mahwah, NJ: Lawrence Erlbaum, 2004).

Learning and Understanding: Improving Advanced Study of Mathematics and Science in U.S. High Schools, edited by J.P. Gollub et al. (Washington, DC: National Academy Press, 2002).

Mixing It Up: Integrated, Interdisciplinary, Intriguing Science in the Elementary Classroom, by the National Science Teachers Association (Arlington, VA: NSTA Press, 2003).

The New Science Literacy: Using Language Skills To Help Students Learn Science, by Marlene Thier with Bennett Daviss (Portsmouth, NH: Heinemann, 2002).

Rubrics for Assessing Student Achievement in Science, Grades K-12, by Hays B. Lantz, Jr. (Thousand Oaks, CA: Corwin Press, 2004).

Transforming Teaching in Math and Science: How Schools and Districts Can Support Change, by Adam Gamoran et al. (New York, NY: Teachers College Press, 2003).

Organizations

National Science Teachers Association is the foremost professional organization for science teachers in the U.S. Along with many classroom resources and professional development opportunities, it also publishes a journal for each grade configuration. www.nsta.org

Science & Children
www.nsta.org/elementaryschool#journal
Science Scope
www.nsta.org/middleschool#journal
Science Teacher
www.nsta.org/highschool#journal

The National Teachers Enhancement Network (NTEN), operated by Montana State University-Bozeman and funded by the National Science Foundation, provides online professional development courses for K–12 science teachers. Its Web site has a useful resources page and an online discussion forum for teachers. www.scienceteacher.org

Sites for Teachers is a gateway site that includes a science page with lesson plans, instructional materials, and links to the major science education organizations. www.sitesforteachers.com/resources_sharp/index.html

For additional resources, see our Web exclusive.

Resource Annex

What the Statistics Say About Highly Qualified Science Teachers *By Richard Greenough*

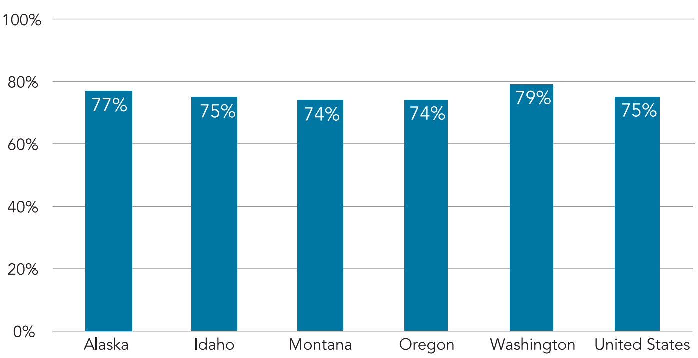
NORTHWEST SCIENCE TEACHERS WITH SCIENCE MAJORS

	Northwest	United States
1994	81%	74%
2000	74%	75%

The proportion of Northwest teachers whose main assignment was science and who majored in science dropped significantly from 1994 to 2000. The proportion remained static for the nation as a whole.

Source: NCES Schools and Staffing Survey, 1999–2000 (in the Council of Chief State School Officers' State Indicators of Science and Mathematics Education, 2003)

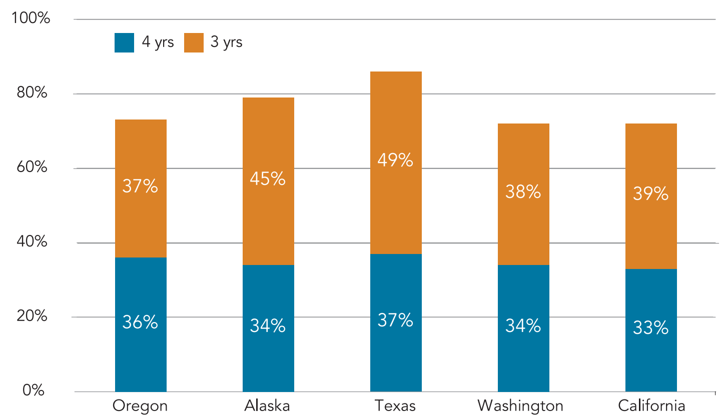
A STATE-BY-STATE COMPARISON OF NORTHWEST SCIENCE TEACHERS (GRADES 7–12) WITH SCIENCE MAJORS



More than one in five Northwest middle and high school science teachers whose main assignment is science don't have a major in science.

Source: NCES Schools and Staffing Survey, 1999–2000 (in the Council of Chief School Officers' State Indicators of Science and Mathematics Education, 2003)

NATURAL SCIENCES COURSE-TAKING BY COLLEGE-BOUND SENIORS



College-bound seniors in three Northwest states are neither lagging nor leading in natural sciences course-taking, when compared to their peers in states with closely comparable SAT participation rates of 49–56 percent.

Source: College Board, College Bound Seniors 2004: State Reports

SCIENCE COURSE-TAKING BY SENIORS IN NORTHWEST STATES

	Biology	Chemistry	Physics	SAT-Takers
Alaska	95%	70%	34%	53%
Idaho	94%	77%	43%	20%
Montana	97%	75%	45%	29%
Oregon	95%	75%	45%	56%
Washington	93%	78%	43%	52%
United States	97%	87%	50%	48%

Source: College Board, College Bound Seniors 2004: State Reports

CORRECTION

In "Region at a Glance" in "Online Schools: A New Frontier in Public Education" (Northwest Education, *winter 2004), Chart 1 should have been titled: Percent of Northwest Students in Title I Schools (the chart includes all students in the Northwest, not just low-income students). Chart 2 asserts that only 89 Washington Title I schools are not meeting AYP. However, that is the number not meeting AYP for the first time this year. Also, there are 957 schools meeting AYP and not in school improvement.*

END NOTE

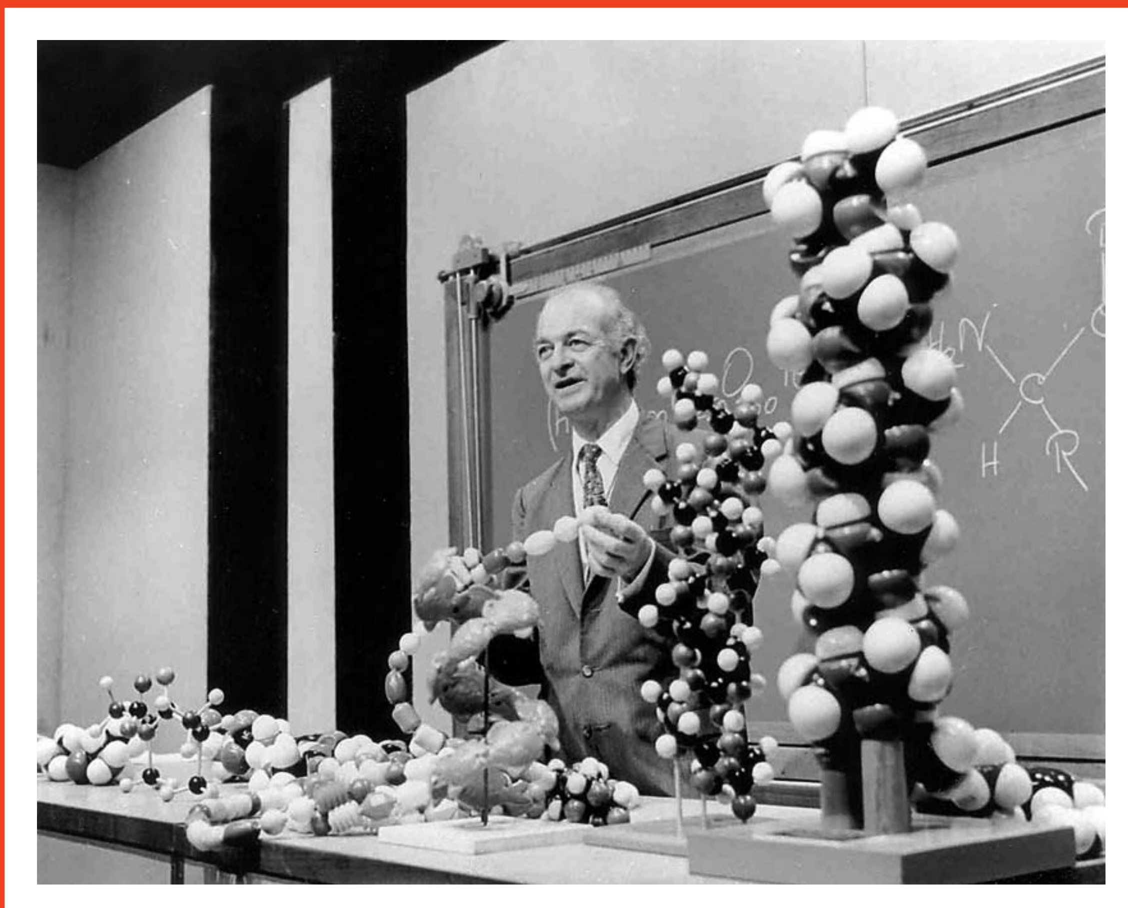


Photo courtesy Ava Helen and Linus Pauling Papers, Oregon State University Libraries

An Eminent Native Son

Native Oregonian Linus Pauling is the most famous scientist to come out of the Northwest and some would argue the most important American scientist of the 20th century. Despite the fact that he never earned a high school diploma—dropping out early in his senior year—he completed a doctorate at age 24 and was appointed full professor at Cal Tech five years later. The only person in history to win two unshared Nobel Prizes—one for chemistry and a second for peace—Pauling was recognized for his work on the chemical bond and the structure of complex molecules and for his battle against the spread of nuclear weapons. To mark the 50th anniversary of his chemistry prize, the Oregon State University Libraries launched a Web site in 2004 that offers a documentary history of their distinguished alumnus: http://osulibrary.oregonstate.edu/specialcollections/coll/pauling/bond/index.html. February 28, Pauling's birthday, is observed each year as Linus Pauling Day at OSU.

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Up next in the summer 2005 issue:
Coming to Terms With Accountability

NORTHWEST
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