Do-It-Yourself Science

Walk into Daniel Menelly's science classroom and you'd never guess that you were walking into something extra-special. There are science words on the chalkboard, science equipment on shelves and, everywhere you look, students hard at work on science projects. As far as physical appearances go, it could have been a middle school science classroom anywhere.

But talk to Menelly and the eighth graders he teaches, and look at some of the projects the kids work on, and you get the idea that something extra-special is really going on. Chemistry cookies. Take, for example, this chemistry activity. It's a recipe for chocolate chip cookies and it begins with these mind-boggling ingredients:
1.) 532.35 cm3 gluten
2.) 4.9 cm3 NaHCO3
3.) 4.9 cm3 refined halite
4.) 236.6 cm3 partially hydrogenated tallow triglyceride

There are 10 ingredients in all, followed by a set of scientifically precise instructions. (Sample: "To a 2-L jacketed round reactor vessel (reactor #1) with an overall heat transfer coefficient of about 100 Btu/F-ft2-hr, add ingredients 1, 2 and 3 with constant agitation.") The recipe ends with this admonition: "P.S. Don't try this at home." There are more challenging activities where that came from. A lot more.

When Teaching K-8 paid a recent visit to Menelly's classroom at Dodd Middle School in Cheshire, Connecticut, his students were nearing the end of a four-day project that involved rating household products. The students had formed teams of from one to five and had chosen - one product to a team -- from a long list on the chalkboard that included such items as glass cleaners, detergents, glue, degreasers, scouring pads, sweeteners, butter and fish food.

Once the products were chosen, the kids were pretty much on their own. First, they were asked to select three or four brand names; they then had to identify three of the products' variables. Four boys who were investigating anti-bacterial soap, for example, settled on cost, smell and germ-killing power as their three variables.

But the challenge was just beginning. The teams were then expected to devise and carry out tests for all three variables. Cost and smell are relatively easy, but how about germ-killing power? The boys set up cultures of chicken broth, added soap and, a few days later, used a microscope to examine the cultures for bacterial growth.

Testing variables. Here are two more bright ideas the kids came up with to test variables:

* A team investigating the carbon dioxide content of leading brands of soda put balloons over the tops of cans, shook the cans, which released the gas and noted the size of the balloons.

* A team investigating the staying power of perfume sprayed three colored balloons with perfume, hung them on a tree outside[cont. on p.36] the school for six hours and then polled other students to see which perfume was the strongest.

Where was Menelly while all this was going on? In constant motion around the classroom, that's where. When students need encouragement or a few helpful suggestions, he's never very far away. But even so, essentially it's still the kids' show.

Constructivist approach. Here's what Menelly has to say about giving the kids a large piece of the action. "I've been modifying instruction in my classroom to center on a more constructivist approach. I'm not interested in the approach because it seems to be the current trend, but because it really seems to suit the way middle school science students seem to learn.

"I recently ran a wave physics activity, where students were encouraged to design their own wave physics experiments with materials I placed at different stations throughout the room. I was encouraged to see students assembling some very effective and simple science experiments.

He continued, "When I questioned students about what they were doing, they were able to make some pretty meaningful connections between their own experiments and some of the abstract ideas encountered in class discussions. That's an outcome I sometimes don't see when students run through prepared 'cookie cutter' labs."

Menelly has also been experimenting with student-centered research opportunities. He cited a recent activity where students were grouped by interest, not ability, to research one of five theories of atomic structure.

"I wanted theto build their own foundation for the study of matter and chemistry, so I had them explore the fundamental theories of atomic structure," he said. "Students went online for research data, pored over science reference materials and even waded through some philosophical references, studying Democritus and the Greek theories of the atom."

Woven into all this do-it-yourself science is an assessment process that often encourages the eighth graders to be their own judge of how they're doing. Following the testing of household products, for example, students critiqued each other's experiments and also wrote about what they thought they could have done better on the project and what they did that no one else did. (One student noted that he had sounded out the school nurse about a certain brand of anti-bacterial soap.)

Special needs. Menelly teaches four sections totalling 97 students. Joining him for some of his classes is Janet Johnson, an instructional assistant who is also a certified

teacher. Menelly also keeps in close touch with the school's special ed teachers. This is important, he noted, since 23 of his students have special needs. Also, many of these students have never before been mainstreamed into a regular science class.

Other approaches. It's not one science experiment after another in Daniel Menelly's classes. Throughout the year, he comes up with other approaches to science -- through language arts and social studies, for example. Later this year, he'll team up with a language arts teacher to teach kids about the Holocaust. In language arts, students will read The Diary of Anne Frank; in science, they'll study German scientists who were persecuted by the Nazis.

"I'm also reinforcing some of the more practical issues in science, like building a working science vocabulary," Menelly said. "The kids recently had a fun time with an activity I call 'The Living Puzzle.'

"I randomly distributed 'Living Puzzle' pieces to my students. Some had science vocabulary terms, others had graphs and schematic diagrams depicting the vocabulary terms. The students were then asked to locate the 'matching' image or word and sit next to the student possessing it.

"Once everyone was seated, I asked students to explain why they chose certain partners," Menelly said. "In pairs, they explained and described their terms in a language their peers could understand. My role was really a small one. I simply set up the puzzle and ushered students off in different directions, encouraging them to ask each other if their pieces 'fit together.

' "It was such a simple, almost elementary activity, but I was impressed with the students' mastery of the new science terms, and I was able to avoid the rote treatment of this material that sometimes turns kids off."

Heart of the matter. Menelly's science projects don't get any easier as the school year rolls on. Soon, his students are going to be asked to solve an insulation problem that goes like this: A living heart is offered by a donor on the west coast to a heart transplant patient on the east coast. Design a container that will allow the heart to remain cool while being shipped.

What do the students think about taking charge of their science education? When Teaching K-8 questioned them, they said things like, "We're having fun," and "It beats just listening." But that day, one action (or perhaps it was a non-action) spoke louder than words. The bell had rung and all of the students had left for lunch, except for two girls engrossed in their project.

"Did you see those two girls?" Menelly said later. "They have friends they meet for lunch and usually they're the first ones out of the door. But today, they were all wrapped up in science." He stopped and thought about it for a moment, and then said, "I'm really encouraged." Need to check out a chemical element? Just take a look at the periodic table on the wall.

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SCIENCE ACTIVITIES FOR THE PRIMARY AND INTERMEDIATE GRADES

The following activities have been adapted for younger children from Daniel Menelly's repertory of middle school science activities. These ideas work well at all levels so why not make them part of your curriculum?

Fathoms deep. Most young children are fascinated by the animals that dwell at the very bottom of the ocean, near the volcanic heat vents that release hot sulphur. In the 1970s, scientists discovered a world of bizarre sea creatures (giant clams and six-foot-tall tube worms with bright red fringes) that live on sulphur.

Use the overhead projector to show primary graders pictures of these creatures. Then have students draw their own versions of the marine life they think might be living at the bottom of the sea. What can the children tell you about the animals they've created? Menelly once asked an intermediate class to compare the deep sea discoveries to those of Darwin a century earlier. "The kids made some excellent comparisons between the tube worms and the strange, long-legged hare discovered by Darwin," Menelly said.

Recommended reading: Fire Under the Sea: The Discovery of the Most Extraordinary Environment on Earth -- Volcanic Hot Springs on the Ocean Floor by Joseph Cone (Morrow, 1991) and Water Baby: The Story of Alvin by Victoria A. Kaharl (Oxford University Press, 1990).

Glow-in-the-dark. Primary and intermediate graders alike can have fun exploring ultraviolet light. Have students bring in luminous objects like neon highlighters, stickers, charms, luminescent nail polish, posters and toys. Under black light, glow-in-the dark materials take on a brilliant, electric-white hue. Later, when studying the luminescence of phosphors in ultraviolet light, the students will have had a striking frame of reference.

Insect images. Run micrographs (drawings or pictures of objects as seen through a microscope) of insect heads and appendages, through a copier onto transparencies and project them on a white wall. The effect can be startling.

When showing a transparency of an insect's head to primary graders, point out that the headlamp of a car is modeled on the compound eyes of insects. Encourage the children to check it out for themselves with the family car. No reason why older children can't do the same thing. They can also try their hand at sci fi stories, using the huge insect images as a starting point.

Make-a-dinosaur. Children ages 8 and up can construct their own paper model skeleton of a Brontosaurus, a long-necked, short bodied reptile that often weighed over 30 tons. The dinosaur patterns in Cut and Make a Dinosaur Skeleton by A.G. Smith (Dover, 1988) can be photocopied for students to transfer and enlarge on graph paper to make models of different scales.

Kids enjoy forming teams to construct these models, and teachers can make some excellent math/science/art connections that really resonate with students.

An added plus: Since the book costs less than $3.00, the activity can be done for almost no money at all. (P.S. Dover has another similarly priced book recommended by Menelly as "one of the best hands-on science books." It's Nathan Shalit's Cup and Saucer Chemistry.)

Menelly regularly selects a picture of an invention from a book about old patents, and challenges students to guess what the invention is all about. The invention shown here? Well, if you had a pet mouse and a swimming pool, and the mouse fell in the pool, it would have an easy climb out. This invention (and the others Menelly shows) is from Peculiar Patents: A Collection of Unusual and Interesting Inventions From the Files of the U.S. Patent Office by Rick Feinberg, Copyright (c) 1994, published by arrangement with Carol Publishing Group, a Citadel Press book.

Want some extra-special science activities for all elementary grade levels? Easy enough. Simply send a stamped, self-addressed envelope to Daniel J. Menelly, Box 1311, Cheshire, CT 06410.

Author: KATIE P. McMANUS Located in an idyllic setting, Dodd Middle School is the only middle school in Cheshire, a New England community of some 26,000Menelly and Instructional Assistant Janet Johnson, a certified teacher with a love of science. Dodd Middle School Principal Donald F. Wailonis and Assistant Principal Sharon W. Weirsman.