Never Too Young for Science

A program aimed at preschoolers exploits their natural curiosity and hands-on predispositions.

FOR 4-YEAR-OLDS, WHAT COULD BE more fun than playing with water? And from a science educator's point of view, what could be more powerful than tapping children's fascinations?

In a Head Start classroom at Dominion High School in Loudoun County, Virginia, children dressed in purple smocks are exploring the concept of volume by pouring water from a bucket into another container with a line marked by masking tape. Using beakers and liter containers, they pour water in or take water out, repeatedly trying to judge how much liquid they need to fill the container to the mark. "They are learning to use the tools in ways that were intended—and maybe in ways that were not intended. But they are excited about learning, and that's wonderful," says teacher Kathleen Miller.

In Loudoun County public schools and select schools in two other states, an innovative preschool science program provides such activities to help children begin to think critically and solve problems. The curriculum, steeped in research about how children learn, capitalizes on their natural curiosity and trains teachers and parents to arouse that curiosity.

Teachers can choose from 21 activities in a toolbox that contains experiments, questions, and suggestions. In one activity, students learn to observe and compare by making a fruit salad, discussing the similarities and differences in the pieces of fruit, and counting the number of pieces of each type of fruit they add to the salad. In another activity, children use a pan balance to weigh objects, determine which are heavier or lighter, and sort them by weight.

The activities can be integrated seamlessly into the preschool day, allowing teachers to take advantage of "teachable moments" to reinforce or extend concepts, says Odette Scovel, science supervisor for the Loudoun County schools. To help children develop literacy skills, teachers read them science-related books and encourage them to talk about what they are doing as they work.

Supported by a 2-year, $50,000 grant from HHMI, the program partners the Loudoun County schools and Florida's Fairchild Tropical Botanic Garden, whose staff also work with preschool science teachers at the Miami site of the Children's Home Society of Florida, which serves thousands of children eligible for adoption or foster care. Selected preschool classes in Harrisburg, Pennsylvania, also use the program. The grantees collaborate with the curriculum's developer, Cognitive Learning Systems (CLS), also of Harrisburg.

"So much is going on in children's brains when they are doing something as simple as pouring water," says Joanna Garner, vice president for program development at CLS. She provides teachers and parents with a "science-behaviors checklist" to determine how well children are using

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Students Drawn to Debate on Evolution and Religion

Must evolution and religion be at odds? A theologian, a philosopher, and two scientists help high school students grapple with tough questions.

MANY PEOPLE THINK SCIENCE AND religion make uncomfortable bedfellows. Father James A. Wiseman isn't one of them.

"I am a believing Christian who totally accepts evolutionary theory," the Benedictine monk and theology professor at the Catholic University of America told a group of Washington, D.C.–area high school students. The teenagers gathered at HHMI headquarters for a discussion following the 2005 Holiday Lectures on Science, which focused on evolution.

In addition to Wiseman, the panel included Michael Ruse, a philosophy professor at Florida State University, and the two Holiday Lectures speakers, HHMI investigators Sean B. Carroll of the University of Wisconsin–Madison and David M. Kingsley from the Stanford University School of Medicine.

The high school students peppered the speakers with challenging questions:

(Left to right) Father James Wiseman, philosopher Michael Ruse, and scientists Sean Carroll and David Kingsley

"Should evolution be taught with a disclaimer, presenting it as one theory among many?"

"Could creationism and evolution be different paths to the same answer?"

"Do you believe in God? If so, how do you reconcile that belief with the science that you do?"

Although the speakers brought different viewpoints to the discussion, they agreed that it is possible to be an evolutionist and a Christian. They encouraged the students to use the scientific method to examine the evidence for biological evolution, which Kingsley called "absolutely overwhelming."

"I don't see a fundamental conflict between religion and evolution," he said. "Evolution is a description of how life changes. That's different from addressing where the whole universe came from. Darwin says nothing about why the universe exists. There is still the critically important 'why' question of how the universe came to be that isn't addressed by evolutionary theory."

Ruse observed, "I can't see why one can't be both an ardent Darwinian and a

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FOR MORE INFORMATION
View the lectures and discussion at
www.hhmi.org/biointeractive/evolution
A free DVD of the Holiday Lectures on evolution and the discussion of evolution and religion will be available in April 2006.

Paul Fetters

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(JOAN STEITZ)
somewhere else," says Steitz. If this turns out to be the case, the RNA portion of a snRNP would be considered a ribozyme.

By this time, Steitz had already advanced up the Yale ladder to become a full professor. Her lab subsequently discovered a second spliceosome that eliminates a rare class of "black sheep" introns that have atypical sequences at their splice sites.

And with her discovery of another kind of snRNP particle, small nucleolar RNPs (snoRNPs), she proved that the term junk DNA was a misnomer. Introns, the so-called noncoding regions of DNA, sometimes code for the small nucleolar RNA found in a snoRNP. These molecules (pronounced snow-RNPs by Steitz) chemically modify ribosomal RNA and are essential to its function.

Currently, Steitz is exploring viral snRNPs as well as the welter of effects splicing has on the downstream life of an RNA message. "For instance," she says, "we know that in the process of splicing proteins are put on RNA that are important for getting the RNA out of the nucleus to the cytoplasm."

While her work is on the bench side of science, others are translating her findings in the clinic in ways Steitz finds "absolutely amazing." A recent paper in *Science* details a way to use aberrant splicing to prevent the ravages of muscular dystrophy in dog models. "Basically, they designed a snRNP to undo the drastic consequences of a mutation," Steitz marvels. "I think that is just extremely cool!"

THE PLEASURE OF HER COMPANY

Apart from the official kudos Steitz has received, including the National Medal of Science, postdocs and graduate students in her lab say it's a genuine pleasure to be there. They rave, for example, about her "really great parties." At their most recent Halloween bash, Joan was the Statue of Liberty and Tom was Uncle Sam. And Doudna recalls delightful afternoons spent sailing with Steitz and her husband, drinking wine, discussing science—or the wind. "Working as a postdoc under Joan was such a fantastic experience," says Baserga, "that I spent the first several years on my own wishing I were still there."

While science itself is clearly Steitz's first priority, education is her second. "I adore teaching undergraduates and consider it a privilege to interact with the fabulous students at Yale," she says. Her recent participation in a committee that wrote the National Academy of Sciences report titled "Bio 2010" inspired her to completely revamp a course for advanced undergraduates that teaches them, by group participation, how to read the literature. "Almost every time I lecture at another university, someone comes up to me and says, 'I took your biochemistry course back in 19xx, and it was terrific.' What more can one wish for?"

Another passion is a desire for women scientists to be appreciated as men's equals. Steitz stands firmly by her 2001 comment in *The New York Times* that a woman scientist needs to be twice as good for half the pay, although, Thomas Cech points out, she doesn't picket for change but rather leads by example. Steitz spends time on oversight issues to remedy remaining inequality problems—time she would far rather devote to her science.

She bristles when asked about Harvard President Larry Summers' recent suggestion that women have less innate scientific ability. But she's certainly circumspect in her reply: "What he said, and the sequelae at Harvard and throughout the nation, is the best thing to happen for women in science since the MIT report." She is referring to the report out of MIT in the late 1990s that found women scientists at that institution suffered significant discrimination in terms of pay and stature. After that report was made public, remedial changes were initiated at many universities. Steitz says she is optimistic that Summers' comments will again prompt positive change for women in science. Regarding his continuation as Harvard's president, post-gaffe: "That's something I find very interesting," replies Steitz without expression.

It's not hard to imagine how she would respond to Dr. Famous today if he questioned her place in and dedication to science. She might show him her weighty CV and invite him sailing with her beloved son and husband to remind him that a career in science does not exclude a happy family life—even without the station wagon. ■

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(ERIC BETZIG)

Do you have thoughts on how to speed up progress?

EB: Well, that gets into the wider philosophical issues of how research is done, which Janelia will try to address in some ways. In particular, I'm hopeful that the innovative engineering group within Janelia will help, at least for stuff we start to develop internally.

The problem with the near-field microscope—a device I was using fairly successfully—was that there was no mechanism for turning it into a good turnkey instrument. And it's still too embryonic for most biologists to consider using. There are hundreds, if not thousands, of examples in science and technology of good ideas that just languish because of the gulf that exists between the conception/demonstration of an idea and something that's economically viable.

My hope is that Janelia will be a step in the right direction, because mechanisms will be in place there to take ideas that have been shown to work from a proof-of-principle standpoint to the point where they might be broadly applied. Right now, that's pretty damn rare. **–Interview by Jennifer Michalowski** ■

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tools, observing, drawing conclusions, and making predictions.

Evaluations show that the children's vocabulary for the names and functions of science tools increased significantly over a 5-month period during the 2005 program and that most were able to select the appropriate tool to solve a new problem. The results "tell us that children not only know how to use the tools but are also more likely to transfer that knowledge into a new situation," says Garner.

"When we looked at outcomes," adds CLS president Keith Verner, a former HHMI grantee at the Penn State College of Medicine, "we saw increases that were not dependent on a particular teacher or a particular class. We believe it was the program itself that made the difference."

Loudoun County's Scovel agrees, and notes, "We don't want to repeat what children will learn in kindergarten, but we want to build skills they can use in kindergarten and beyond." **–Judith B. Saks** ■

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(EVOLUTION/RELIGION DEBATE)
nonbeliever like myself or a believer like Father Wiseman. It seems to me that [science and religion] are two separate things." He added, "The Bible is not a work of science."

"I find it beyond ironic that society depends on DNA evidence for questions of life and death," Carroll remarked, "yet we're not willing to contemplate the DNA record of natural history and evolution." **–Jennifer Boeth Donovan** ■