A third of states—and many individual districts—have now adopted the Next Generation Science Standards, which emphasize scientific inquiry and link broad concepts across the science fields. But many teachers are saying they still have few instructional resources to help them bring the new benchmarks to their classrooms.

The American Association for the Advancement of Science, an international nonprofit, announced at its annual meeting last week the release of a new, research-based curriculum for middle school teachers that's aligned to the NGSS. And according to early piloting, the eight-week-long unit is having quite an impact on science learning.

The curriculum, created by the group’s Project 2061 initiative, aims to teach foundational concepts about atoms and chemical reactions that are essential for high school biology, Jo Ellen Roseman, the Project 2061 director, explained last week.

Too many students come into biology with basic misperceptions about chemistry, she said. For instance, they don’t see gases as having mass, or they think atoms are transmuted rather than rearranged during chemical reactions. The "Toward High School Biology" unit, which received funding from the U.S. Department of Education's Institute of Education Sciences and went through five years of development, focuses on the molecular basis for biology—and it does so by introducing students to different scientific phenomena in a hands-on, inquiry-based way.

Teachers Try It Out

In an afternoon teacher workshop at the AAAS meeting, Project 2061 representatives and a few teachers that have piloted the program led small groups of educators through some of the demonstrations.

In an experiment from the first chapter, the teachers watched what happens when iron and air mix. Cari Herrmann-Abell, a senior research associate for Project 2061, soaked a piece of steel wool in vinegar to dissolve the protective coating, then placed the wool into a flask. Then she covered the top with a piece of a latex glove.

Students doing this experiment would feel the flask warming right away. The teacher shows that over time, they would eventually see the latex get sucked into the flask and rust begin to form on the steel wool.

"We don’t talk about reactions at first, we talk about investigations, changes, observations," said Herrmann-Abell. "Something is happening to the matter in there that’s changing the system."

Modeling Atoms Rearranging

The group then switched to Legos to model what was going on with the atoms during that chemical reaction. They used a brown Lego to represent iron and two reds together to represent oxygen. Then they reconfigured those Legos to form a new chemical—rust. The Lego modeling shows students that the atoms don't actually change or disappear in the closed system; they just rearrange.

"Once they've experienced it on substance level and modeled it on a molecular level, we can start adding some vocabulary” about chemical reactions, said Herrmann-Abell.

The curriculum requires quite a bit of writing, the teachers who’d piloted it told the AAAS attendees. For each demonstration, students document what they observe and attempt to explain it using evidence.

"I teach a population of students that are very reluctant writers so though I was very excited about the unit, I was concerned about how my students would react to all that writing," said Leah Donovan, a middle school science teacher in Howard County, Md., who tested the curriculum in her classroom. "I have to say that every year I've taught the unit, they've risen to the occasion."

'Very, Very Large Effect Sizes'

A randomized control trial that the group conducted with six schools in Maryland showed large effect sizes after students took part in the curriculum. (Many more schools across the country tested the curriculum, but those results were not presented at the conference.) Students took pre- and post-tests on the science ideas included in the unit. Students who learned the Toward High School Biology unit showed much more growth on the post-test than those in control classrooms, in which teachers covered the same material but did not use the curriculum.

For example, the percentage of students who held the misconception that "atoms are changed into other atoms," fell from 31 percent to 23 percent in the control classrooms between the pre- and post-test. But it fell from 33 percent to 14 percent in the THSB classrooms.
The researchers compared the effect size of THSB to the average effect size of 27 other curriculum units, some of which were taught over an entire school year, and found that is was twice as large.

"These are very, very large effect sizes for a unit that's eight weeks long," said Herrmann-Abell.

Schools will need to buy their own materials to go with the curriculum, and those should cost about $1,200, the Project 2061 team said. They will also need to pay for the curriculum to be printed.

Project 2061 is still determining how to release the curriculum, since the teacher's editions can't go online. But the curriculum will be available in some form with enough time for teachers to practice over the summer and be ready to implement it next year, said Roseman.

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Ebasco
6:26 PM on February 16, 2016

There is already too much biology taught by too many biology teachers. This does absolutely nothing to get us closer to teaching students something about SCIENCE using the language of science, MATHEMATICS!! And what is the purpose of an experiment, not to golly gee with parlor tricks. Sad. Middle School students should be treated with greater respect for their ability to learn.

NJB
9:36 PM on February 18, 2016

I think this is an excellent way to illustrate abstract science ideas. Younger students (by that I mean 13 - 15 year olds) have a much harder time visualizing abstracts like atomic reactions, the ability generally grows tremendously within a couple years. A parlor trick that illustrates a tricky concept is GREAT!!

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