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Reinventing science class

How Newport News has revamped its science curriculum—and achieved big gains—by moving to an inquiry-based model

Walk into any science classroom at a middle or high school in Newport News, Va., and chances are you won't see students sitting in chairs, facing the teacher at the front of the room.

Instead, you'll find them huddled in small groups—or outside in the field—designing their own experiments and testing their hypotheses with the aid of handheld technology from PASCO. Students might be measuring the amount of carbon dioxide emitted by plants under various lighting conditions, or testing for fertilizer in the water from a nearby pond.

This is science as it happens in the real world: a hands-on, inquiry-based activity. It starts with a question, which leads students to observe and collect information as they seek answers to their query.

In a typical science classroom, students are taught the content first and then they do a lab activity to reinforce what they've already learned. But Newport News has changed this traditional model of instruction dramatically by having students learn science by actually doing science. "We've really changed our whole philosophy," said Dewey Ray, secondary science supervisor for Newport News Public Schools (NNPS).

And the results have been extraordinary: Average science scores on Virginia's Standards of Learning (SOL) exam have risen anywhere from five percentage points to 19 percentage points for the city's five high schools.

In this special Publisher's Report, we'll look at how Newport News has revamped its science curriculum with the help of PASCO technology—and how this change has led to big achievement gains.

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Origins of the program

NNPS serves nearly 30,000 students on the northern shore of the James River, part of the Hampton Roads harbor area of Virginia. The school system's new inquiry-based science initiative began a few years ago, under the direction of Ray, Superintendent Ashby Kilgore, and Science Specialist Bruce Davidson.

At the time, NNPS instructors were teaching mostly with worksheets and PowerPoint presentations. Students were absorbing the content through lectures and reading. But school division leaders realized that wasn't good enough.

"We live in a community with a large science presence," said Davidson, noting that key employers in the region include NASA, U.S. military facilities, Huntington Ingalls (a shipbuilding division of Northrop Grumman), and other shipyards. "We knew we weren't doing what we needed to do to prepare students effectively for these careers."

In 2010, NNPS applied for and received about $12 million in federal stimulus funding for science, technology, engineering, and mathematics (STEM) education. With this money, the school division redesigned its science labs and rewrote its science curriculum for grades 6–12.

At the heart of these changes was a focus on hands-on, inquiry-based learning. Curriculum specialists designed each unit or theme around an essential question for students to explore. For example, one seventh-grade biology unit on Life Processes is built around the question: "What is the effect of exercise on heart rates?"

Students are challenged to design their own investigations in order to answer these questions. To support this effort, NNPS used some of its STEM education stimulus funds to buy sets of PASCO's SPARK Science Learning System™ for each classroom.

How technology supports this effort

SPARK is a handheld data collection and analysis tool from PASCO. It's a rugged, all-in-one mobile device with a 5.7-inch touch-screen display. It features a rubberized handle that makes it easy for students to hold in one hand, while they collect and analyze information with the other—and its rechargeable lithium battery lasts for a full school day under normal usage.

Student monitor their heart rates with handheld sensors from PASCO.

SPARK's full-color display allows students to view multiple representations of data at the same time, zoom in on key portions of a graph, and stack or overlay two graphs to recognize the relationships between data sets. Using SPARKs, students can also draw a line with their finger to predict how data will appear on a graph, then compare their prediction with the actual results.

SPARKs include built-in temperature and voltage sensors, as well as two ports to plug in any of PASCO's 70+ PASPORT sensors to collect additional information.

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SPARKs also come with more than 60 pre-installed SPARKlabs®, which are standards-based interactive lab activities that encourage students to think about the information they collect and answer key questions about it.

In short, the SPARK Science Learning System is the perfect tool to support a hands-on, inquiry-driven approach to science instruction, Ray says.

For the seventh-grade Heart Rate Investigation, for instance, students are using SPARKs with Hand-Grip Heart Rate sensors to design their own experiments. They collect heart-rate data under various conditions, then analyze the data to draw their own conclusions about the effects of exercise on heart rates—and how this is connected to life processes.

Ray had tested SPARKs in a program at Heritage High School when he was the administrator in charge of science there. He recommended that NNPS purchase the devices for all science classrooms in grades 6–12, and these were ordered in time for the 2011–12 school year.

NNPS also bought a set of 30 laptops for each high school science department, as well as site licenses for PASCO's SPARKvue® software, which enables students to collect and analyze data using the laptops instead of SPARKs.

Keys to success

Before the technology could be used throughout the city's middle and high schools, however, teachers had to be trained. So NNPS sent a team of teachers (including Davidson) to PASCO headquarters in Roseville, Calif., where they learned how to use the technology and how to integrate it into their lessons. These teacher experts then helped train the rest of the school division's science faculty to use the equipment.

Local staff development was organized by grade level and content area, and it involved challenging teachers to set up and conduct investigations "as if they were a student," Ray said. Teachers quickly learned the possibilities inherent in these new tools—and how they could be used to support scientific inquiry.

Proper training has been an important element of NNPS's success. Another key has been revising local assessments to align with these curriculum changes.

Virginia's new teacher evaluation system is based, in part, on student growth from year to year. For their efforts to be successful, NNPS leaders knew they had to come up with ways to measure the new skills they were hoping students would learn—such as problem solving, critical thinking, and demonstration of the scientific process—and then incorporate these measurements into the pre- and post-testing required under the state's new evaluation system.

Toward this end, NNPS leaders developed an "inquiry rubric" that would be used to assess these skills—and they've added inquiry-based projects or activities to their pre- and post-testing practices. For its local assessments, NNPS also embeds screenshots of data plots that students should recognize from the labs they have completed. Then students are asked to explain what is happening in terms of the science involved.

"We've raised the bar on assessment," Ray said. "Students must be able to read each graph and interpret what it means."

Impressive results

This new approach to science instruction is paying dividends for NNPS students. For one thing, average scores on the "Scientific Investigation" portion of Virginia's SOL exam have risen from the 2007–8 school year to the 2011–12 school year for all five of the city's schools serving students in grades 9–12. The gains range from a five percentage-point gain in earth science at Heritage High School to a 19 percentage-point gain in biology at Woodside High.

NNPS officials believe these gains reflect a deeper understanding of scientific concepts and principles. When students are learning in a hands-on fashion—seeing, perceiving, analyzing, reflecting, and constructing new knowledge for themselves—they develop strong problem-solving and critical thinking skills. When they do science, and not just read about it, they learn to think like scientists, and they retain more information.

Beyond test scores, NNPS students and teachers report a greater appreciation for science. Three out of four students agreed the use of probeware technology has helped their understanding of science concepts, while roughly the same number agreed they would prefer to use the probeware to learn science.

"I like doing hands-on experiments, because it helps me see and understand the concept," one student wrote.

Ninety-five percent of teachers rated student participation as a "3" or higher on a five-point scale, and 65 percent agreed the use of probeware has increased their students' understanding. Teachers report that students are having deeper discussions about science and they are asking higher-level questions, and they are more actively engaged in the labs and the lab write-ups, too.

"We're seeing the students more engaged in their lessons," Davidson said. "And teachers are much more engaged in their teaching." eSN

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