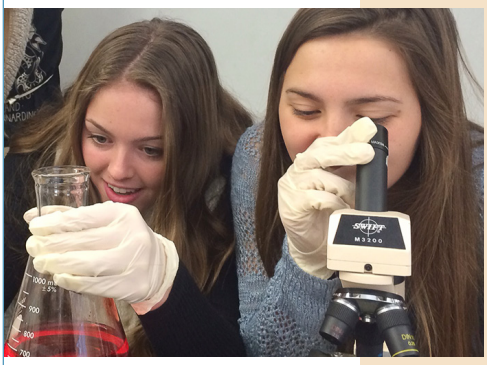
Courage & Discovery

Exploring the Next Generation Science Standards

We cannot discover new oceans unless we have the courage to lose sight of the shore. These words, often attributed to novelist André Gide, may be worth remembering as schools across California begin making the shift to the Next Generation Science Standards.

The field of science plays on our curiosity, driving us to discover new things and seek explanations, to go beyond what's known and see what's really out there. Similarly, preparing for the 2015-16 implementation of the new science standards challenges our traditional ideas about science education and pushes us to explore new worlds. Right now, the unknown seems daunting—like sailing toward the horizon without a compass—but science offers us strategies for moving forward systematically in this new world of 21st century education.



Schools have the opportunity to experiment, reflect, and **gradually make this shift** in science education

Pictured above: Students at Maria Carrillo High School conduct an inquiry investigation.

WHAT IS NGSS?

The **Next Generation Science Standards** (NGSS) were envisioned by practicing scientists and educators in 2011 as a revised framework for science education, replacing standards that were written 15 years earlier. The update responded to the many scientific advances that had occurred, as well as the growth in science, technology, engineering, and mathematics (STEM) careers. It also emphasized science literacy and sought to promote understanding of how humans influence and are influenced by the natural world.

The NGSS developers acknowledge that standards are not a silver bullet in promoting scientific learning. The standards are intended to provide a foundation that allows educators to develop curriculum, instruction, and assessment. Coupled with teacher expertise, the standards provide opportunities for students to learn science-specific skills, gain content knowledge, and develop critical thinking and inquiry-based problem solving abilities.

The standards have multiple layers. The top layer is **performance expectations**, which are different from traditional content standards. Instead of focusing on what students should *know*, the performance expectations focus on what students who demonstrate understanding can *do*.

Underlying and informing the performance expectations are three dimensions that flow within and across all science content areas:

- Science and Engineering Practices
- Crosscutting Concepts
- Disciplinary Core Ideas

When integrated, these dimensions of scientific study provide a comprehensive view of the content being learned, knowledge of how scientific information is acquired, and understanding of the overarching themes that extend across all areas of science.

It's important to recognize that NGSS is not the same as the Common Core State Standards, but the two are aligned. The writing teams worked together to ensure that the science standards didn't outpace the math standards at any grade level and to identify specific overlaps between the math and science standards.

Similarly, the writing teams determined which literacy skills were aligned with science content demands. For example, teams made connections between the Science and Engineering Practices and the Common Core literacy anchor standards. Both involve gaining knowledge from informational texts, diagrams, and data; assessing information and claims; and making arguments based on evidence.

NGSS timeline

- **Sept 2013**
  NGSS officially adopted in California
- **Nov 2014**
  Implementation plan approved
- **2015-16 school year**
  Implementation process begins
- **2016**
  Assessment recommendations expected
- **2017**
  Instructional resources available
- **2018-19 school year**
  Assessment likely to begin

NGSS is not the same as the Common Core State Standards, but **the two are aligned**

MOVING TOWARD IMPLEMENTATION

The good news about NGSS implementation is that it isn't all or nothing. Implementation is expected to be a gradual process as teachers, students, and administrators work together and learn from each other. As a result, schools have the opportunity to experiment, reflect, and gradually make this shift in science education.

And here the practice of science offers some assistance: scientific investigation isn't about jumping into a void just to see what's there. Science involves careful questioning, systematic study, and analysis. It's messy and may require repeating and revising experiments, asking new questions, and sometimes changing directions. It can invoke a sense of adventure—many scientists have quite literally sailed away from the safety of shore—but it always involves thoughtful exploration.

Most important, science builds on the work of those who have come before. As Isaac Newton said, "If I have seen further than others, it is by standing upon the shoulders of giants."

NGSS calls for students to develop the skill to **think and act like scientists**, and it's only fitting that educators do the same as they begin NGSS exploration and implementation.

"We should experiment with implementation and see how aspects of NGSS can be incorporated into existing lessons," says Anna Van Dordrecht, a science teacher at Maria Carrillo High School and SCOE's teacher-on-loan for science. "We shouldn't be afraid to make mistakes, revise, and try again—or to reflect on and improve our pedagogy as we go. And we should follow the lead of others, building on their strengths and learning from their mishaps."

In the transition to the Common Core Standards and now NGSS, one thing that has become apparent is **the value of teacher leadership and teacher-driven professional development**. Teachers are the ones "in the trenches" who know what the day-to-day experiences and needs of the classroom are. They are integral to the success of these changes in education.

This year, SCOE is investing in two teacher groups specifically focused

on science. One is the BaySci Leadership Team, a group of K-8 educators drawn from nine Sonoma County school districts. They have received training and are committed to incorporating NGSS in their classrooms this year, then helping develop and guide training for others in 2015-16.

SCOE is also working with a group of science teachers from Maria Carrillo High School to develop a model for teacher-driven NGSS implementation. This group is focused on identifying their current teaching strengths, then building on and incorporating those assets in their NGSS transition.

These two teams will provide Sonoma County with a wealth of knowledge, examples of what works, and information about what needs to be addressed. Just as scientists build on each other's work, schools across the county will have the opportunity to learn from these teacher teams that are sailing out in front.

SONOMA COUNTY IMPLEMENTATION EXAMPLES

At Santa Rosa Accelerated Charter School, BaySci teacher **Steve Williams** is incorporating NGSS components into all of his sixth-grade science investigations. This year, Williams and his colleagues at this school have chosen to emphasize data collection and developing claims and explanations supported by evidence.

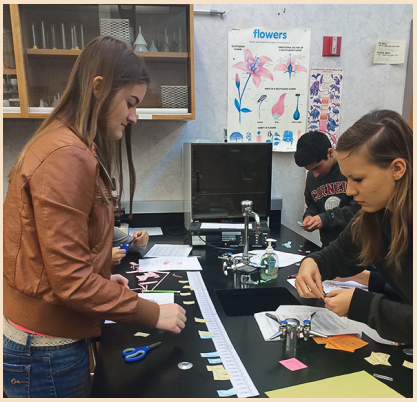
In an investigation of matter involving Kool-Aid dispersion in various substances, Williams led students through the steps for developing a claim and explanation of the phenomenon. Students investigated in teams, used a template to record data, wrote and illustrated their claims, then received peer feedback and pointers from their teacher.

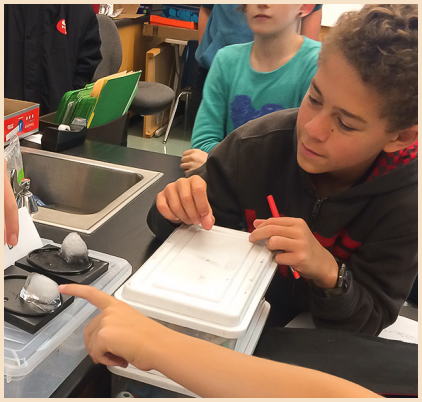
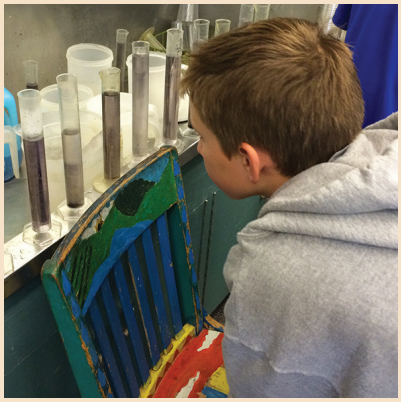
Throughout the lesson, Williams emphasized specific aspects of NGSS so that students were aware they were developing models and making claims that needed to be supported. As they were writing and defending their claims, Williams told his students, "This is what good science is all about. This is what scientists spend their whole lives discussing."

Eric Brockway, another BaySci team member, teaches at Adele Harrison Middle School in Sonoma. He challenges his students not only to learn science content, but to also apply it in their speaking, writing, and project design.

"NGSS has really shifted the emphasis in science from what students know to what students will do," he says. A recent lesson reflected this emphasis. After learning about energy transfer, students were asked to design and construct devices that would minimize or maximize heat transfer. They presented their devices, then redesigned them based on testing data and peer critique. The students incorporated new academic vocabulary and their project experiences in discussions of similar phenomena shown in classroom demonstrations.

At Maria Carrillo High, **Maggie Swarner** chose to focus on modeling, inquiry, explanation, and evidence in her science classes. Working with other members of her department to develop a teacher-driven model of implementation has been key to her classroom innovations.



Students model gene expression at Maria Carrillo High, collect evidence to explain heat transfer at Adele Harrison Middle, and examine the distribution of Kool-Aid at different temperatures to support claims at Santa Rosa Accelerated Charter.

"Our work has brought NGSS to the forefront of my mind," she says. "It's allowed for a slower reflection process and helped me think about what I do, what I should do differently, and what I should modify."

In addition to modifying instruction to emphasize inquiry and incorporate opportunities for students to build and use models, Swarner has reexamined group work and assessment. In one example, she gave students a test with the answers already provided. In groups of four, they had to discuss and explain why the answers were correct.

Swarner says that the activity led to a highly effective class discussion. "NGSS highlights the need to give rationale for claims. This test process produced a higher level of learning than would have come about with a traditional test."

Candice Nichols, also part of Maria Carrillo High's NGSS implementation group, says that the work her team is doing has led to a shift in her role as a teacher. "I'm becoming more of a coach, helping students develop and practice argumentation and reflection skills."

In one lesson, her ninth-grade earth science students tackled Einstein's theory of relativity in an informational text. With guidance, the students were asked to summarize Einstein's arguments in words and drawings, then use what they'd learned as evidence in responding to a writing prompt. The students worked in teams to improve their arguments, then presented their responses to the class. Nichols reported that this was a rich exercise that challenged students to stretch not only their thinking about how the universe works, but also their ability to relay and defend arguments.

WHAT'S NEXT?

As these examples show, there is no one-size-fits-all approach to NGSS. Teachers are building on their own strengths as they learn about and begin incorporating NGSS into their teaching practice.

"However you choose to begin, the most important aspect of NGSS implementation is the willingness to move away from what is safe and comfortable and to venture out into new territory," says Anna Van Dordrecht. "When we do this, we have the potential to discover new possibilities for our students—and for ourselves as professionals."

No one knows exactly how implementation of NGSS will unfold over the next few years. There are many questions to be answered and decisions to be made. What we do know is that NGSS has potential—potential to change the way teachers approach science education and the skills students take with them into the world. Knowing this makes it worth the risk of sailing away from shore. ◆

For more information about NGSS and the resources available to support exploration and implementation, visit scoe.org/science or email Anna Van Dordrecht at avandordrecht@scoe.org.

NGSS starting points

Teachers

- Seek training in understanding how to read and approach the new standards.
- Select an entry point and try implementing aspects of NGSS with your current curriculum. An easy starting place is to identify and emphasize the Science and Engineering Practices.
- Form a team with colleagues to discuss and collaborate about what NGSS looks like in your classrooms.
- Communicate to parents and administrators what the shift to NGSS will mean for your classroom, how it will affect the resources required, and what is being asked of the students.

Administrators

- Learn about NGSS, including why it was developed and what shifts it requires.
- Communicate with teachers about what resources are currently available and what is needed for implementation.
- Invite teachers to be part of the larger implementation conversation.
- Empower teachers to try NGSS in their classrooms, then provide time for them to reflect on and improve strategies individually and in teams.