

## Designing an *NGSS* Learning Pathway

How informal institutions can help teachers implement the *NGSS*

By Kathryn Danielson and Clea Matson

*I*t's Fall 2016, and an experienced third-grade teacher is browsing the menu of upcoming teacher professional development workshops offered by the California Academy of Sciences in San Francisco. This teacher is familiar with the museum as a community resource for science education. In addition to taking her students on an annual field trip to the museum, she has also participated in the mu-

seum's teacher workshops throughout the years, exploring strategies for inquiry or lessons on specific science concepts such as ecosystems. As she scrolls through the menu, she discovers that her state has adopted something called the Next Generation Science Standards (NGSS). Luckily, the museum is offering a one-day Introduction to the NGSS workshop that coming weekend, and she signs up for it. Dur-

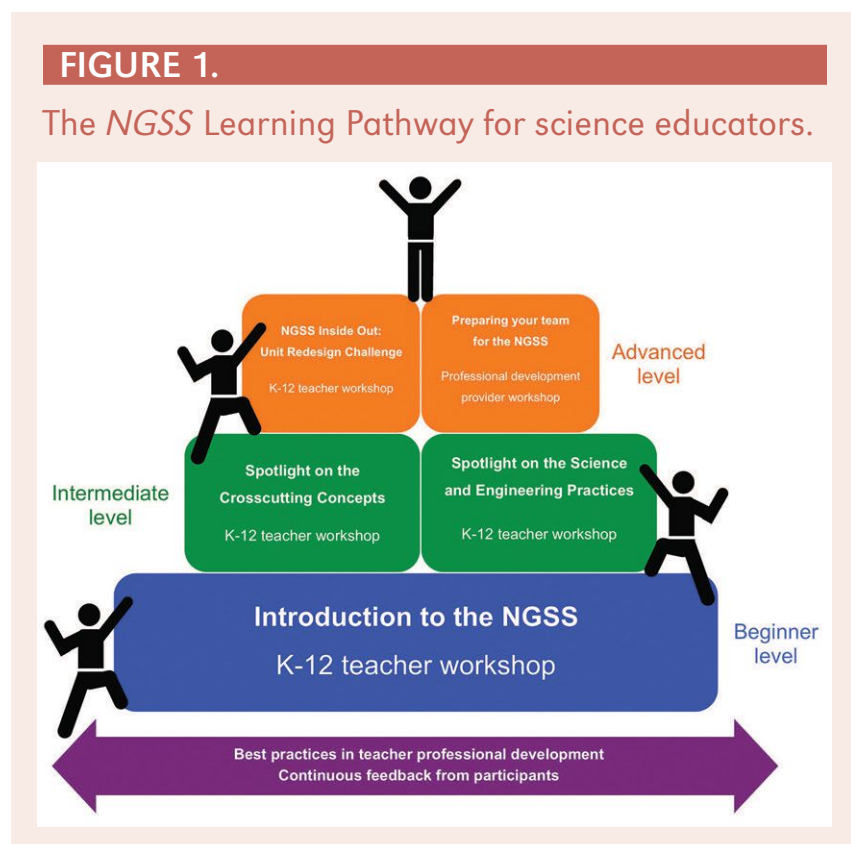
ing the workshop, this teacher meets a second-year middle school teacher, an experienced middle school teacher, and a high school chemistry teacher, all from locations in and around the San Francisco Bay area.

These teachers represent a portion of the audience that museums, aquaria, or science centers might serve with their teacher professional development programs. Informal institutions such as these play a role in supporting teachers in NGSS implementation by developing planning tools and curriculum resources for the classroom (Short 2014). Participating in professional development workshops at informal institutions also allows teachers to tie their experience to what science is and how it serves society. But how do these types of institutions design professional learning programs for such diverse audiences when each educator has different needs, background, and level of preparation?

In this article, we describe four steps that science institutions can take to tie teacher professional development to the NGSS and the needs of their local teacher audience. Since 2013, our museum has been building an NGSS Learning Pathway for preK–12 classroom teachers, professional development providers, and district administrators (Figure 1). This pathway allows educators to experience, practice, and reflect

FIGURE 1.

The NGSS Learning Pathway for science educators.



# Teaching Teachers.

on how the NGSS can make science education more relevant and student-centered. The four steps described here were guided by direct feedback from local teachers about the support they need for their own implementation and where they are in the process. We solicit this feedback in the form of exit tickets at the end of workshops, focus groups, and online surveys. Our hope is that this process might serve as a roadmap for other institutions that are building their own NGSS pathway.

## Step 1: Demystify the Standards

Teachers must first understand the basic structure of the NGSS to develop an appreciation for the new standards (Duncan and Cavera 2015). Our one-day *Introduction to the NGSS* workshop helps K–12 teach-

ers understand the basic structure and reasoning behind the NGSS, so that they are able to start reading and working with the new standards on their own. (For more information about this course, see NSTA Connection.) The workshop starts by answering four basic questions:

- Why are the standards changing?
- What do the new standards look like?
- How were they created?
- What happens next?

Participants next explore each dimension one at a time to build an authentic understanding and appreciation of the science and engineering practices (SEPs) (Figure 2), disciplinary core ideas, and crosscutting concepts (CCCs). When it is time to read the performance expectations

and grade-level content, participants are better equipped to see it all together.

We obtained feedback about this workshop in a couple of ways. At the conclusion of the workshop, participants completed an *exit ticket*, an anonymous feedback card where individuals share something they valued that day, something that could be changed, and a lingering question about the workshop or content. Many participants also responded to an end-of-year online survey sent to all teachers who participated in any teacher workshops during the preceding year. In both cases, we heard from teachers that they leave this introductory workshop with a basic understanding of the structure of the NGSS and their state's timeline for implementation. They are confidently prepared to tell their colleagues about these standards, ask their administrators about implementation plans, and are eager to continue their NGSS learning. Many educators asked for the next level of NGSS learning. While some had access to further learning from their districts, many did not. Recognizing this need led us to develop our next steps in NGSS support.

FIGURE 2.

Teachers get to know the science and engineering practices.



PHOTOS COURTESY OF THE AUTHORS

## Step 2: Shine a Spotlight on SEPs and CCCs

Rather than expecting teachers to design a brand-new NGSS-aligned curriculum from scratch, we focused on how to incorporate SEPs and CCCs with existing content, as an initial step toward shifting teaching practice. We developed two intermediate-level workshops for a K–12

audience: *Spotlight on the Science and Engineering Practices* and *Spotlight on the Crosscutting Concepts*. Each three-day workshop follows a similar structure: framing the purpose and importance of the SEPs, building familiarity with each SEP, exploring model classroom lessons, and providing structured planning time. The CCC workshop follows a similar format to explore the seven CCCs (see NSTA Connection for more information about this workshop).

Each sequence begins with teachers reflecting on their prior knowledge and understanding of one specific SEP or CCC with a quick-write. Then, they hear a “science story” that showcases an SEP or CCC in a real-world context (e.g., how the practice of planning and carrying out investigations helped scientists and engineers bring a 3-D printer to the International Space Station [Greenemeier 2013]). Next, participants engage in a model hands-on lesson that highlights the SEP or CCC. The lesson wraps up with a reflective discussion about any new understanding that may have emerged about the SEP or CCC and how teachers might apply them to activities, science content, or other grade levels.

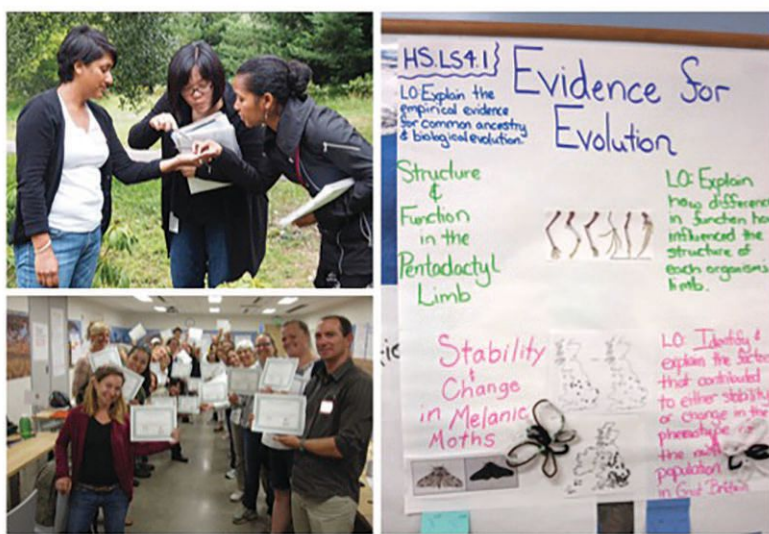
During planning time at the end of each day, participants work in grade-level teams to redesign an activity from their existing curriculum. With support from their peers and from the workshop facilitators, the teachers identify ways to shift their activities to integrate the SEPs or CCCs. The three-day workshop ends with a celebratory showcase of the redesigned K–12 activities, highlighting the connections made to the SEP or CCC (Figure 3).

Teachers often share that they can

**FIGURE 3.**

### *Activities from the Spotlight on the Crosscutting Concepts teacher workshop.*

From top left: Teachers investigate insects found in the museum’s garden during a model lesson about Cause and Effect. An overview of a redesigned high school biology unit that uses Structure and Function and Stability and Change to teach evolution. Teachers show off their certificates of achievement at the end of the workshop, Spotlight on the Science and Engineering Practices.



begin to implement the SEPs and CCCs immediately, before shifting their content or adopting a new curriculum. Teachers also appreciate that they are able to implement new hands-on lessons and activities into their classrooms and can discuss key ideas about these two dimensions with colleagues.

Over time, we began to notice two populations emerging within our teacher audience: classroom teachers who were implementing the NGSS themselves and professional development providers who were designing NGSS training for classroom teachers. Recognizing that these two groups had distinct needs, we developed two different advanced-level learning experiences—steps 3 and 4, respectively—in our NGSS pathway.

## **Step 3: Support a Community of Dedicated Educators**

This advanced-level, three-day workshop called *NGSS Inside Out: Unit Redesign Challenge* explores the key elements of three-dimensional learning and encourages teachers to begin larger shifts in their practice. Participants in this workshop engage as learners in an adult-level, NGSS-style science unit. They then reflect on and discuss the experience, unpacking the pedagogy and teacher moves that supported learning throughout the unit (see NSTA Connection for more information about this workshop). Ultimately, they use their understanding of this



# Teaching Teachers.

**FIGURE 4.**

Participants in the NGSS *Inside Out: Unit Redesign Challenge* workshop explore a model (left) and plan for their own classrooms in a follow-up session (right).



**FIGURE 5.**

A group of professional development providers receives feedback from other teacher trainers at the workshop, *Preparing Your Team for the NGSS*.



pedagogy as a guide for redesigning one of their own science units, while receiving support and feedback from their peers and museum staff (Figure 4).

During the school year, we provide continued support for participants in the form of one-day follow-up sessions. These sessions allow participants to take part in more NGSS model lessons, reflect on their successes and challenges in implementing their redesigned units, and plan their next steps as a community of dedicated educators. This workshop employs best practices in facilitating professional learning communities, including opportunities for peer-to-peer feedback, deep conversations, team norms, and structured protocols, which create an environment of trust (Holmlund Nelson, LeBard, and Waters 2010).

A core group of local teachers has emerged, all of whom attend the entire sequence of beginner, intermediate, and advanced-level workshops and set of follow-up sessions. This group includes teachers from all grade bands who are driven to improve their own teaching through the shifts called for by the NGSS. Upon completing this series, the teachers in this core group reported better understanding of 3-D planning, from phenomena to learning outcomes, and have expressed interest in continuing NGSS learning with the professional learning community developed through the follow-up sessions.

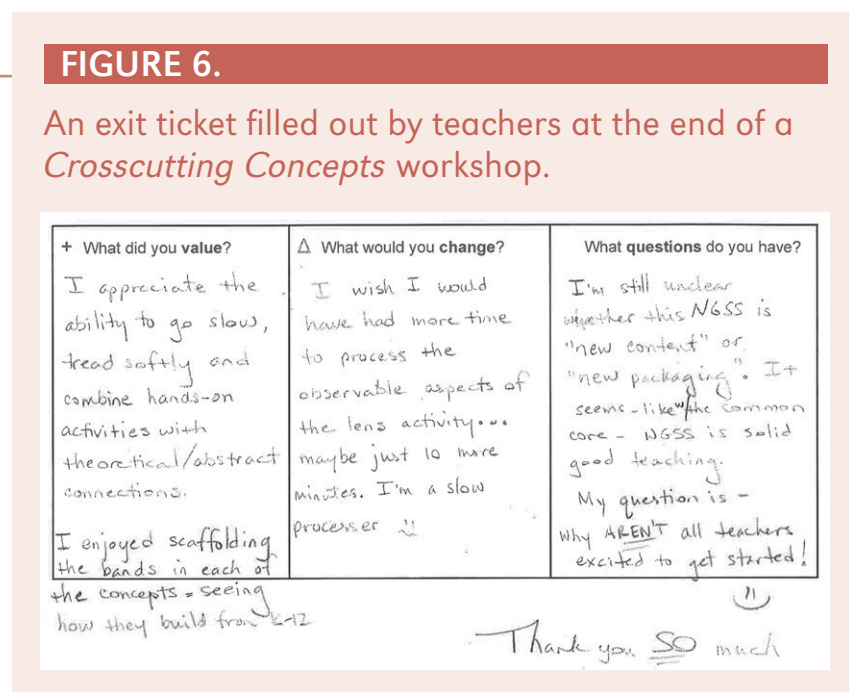
## Step 4: Train the Trainers

Because the NGSS call for significant shifts in the teaching practices

of many educators, there is a wealth of opportunities for professional development and trainings (Brunsell, Kneser, and Neimi 2014). However, many of those responsible for leading this professional development may lack the time, guidance, or resources to develop high-quality programs. Thus, we developed a workshop called *Preparing Your Team for the NGSS*, open to anyone responsible for training teachers on the NGSS. The participants in this workshop include administrators, teachers on special assignment, those who train and support teachers, and full-time classroom teachers who facilitate shorter learning experiences for their peers at staff meetings. (See NSTA Connection for more information about this workshop.)

Participants are encouraged to adapt planning tools and the museum's *Introduction to NGSS* curriculum and to mix and match components with other resources to create a learning experience specific to the needs of their audience. They get support and coaching from museum staff throughout their planning, as well as feedback and encouragement from their fellow workshop participants (Figure 5).

*Preparing Your Team for the NGSS* guides attendees to plan the NGSS training they intend to do with teachers over the course of the next year. The course considers sizeable constraints, especially with respect to how much time they have to both plan for and provide this professional development. This workshop also inspired the creation of a free, online professional development toolkit, *NGSS Demystified* (see Internet Resource), which is designed to help



teacher educators prepare to lead their own NGSS professional development experience. The activities in the online toolkit come from our *Introduction to NGSS* workshop curriculum and are designed to be flexible and modular so that users can easily create a customized learning pathway that meets the exact needs of their group of teachers. A focus group of teachers helped guide the design of these tools while they were still in development, which allowed us adapt them to more closely meet the needs of the audiences.

## Conclusion

The vision and goals of the NGSS will require collaboration and creativity from many stakeholders. Museums, aquaria, and science centers have the expertise to contribute (Short 2014). We offer these four steps for designing an NGSS learning pathway as a starting place, with the goal to support our peer institutions in gradually building their own portfolio of NGSS programs while meeting the needs of their lo-

cal teacher audience. The success of our programs stems from our ongoing and direct dialogue with K-12 classroom teachers, professional development providers, and district administrators. These relationships have allowed us to design a pathway based on what real teachers need to implement the NGSS. Thus, we recommend that any organization developing NGSS programs solicit and use feedback (i.e., exit tickets, end-of-year surveys, and focus groups) to direct their professional development offerings and larger program goals. Figure 6 shows an exit ticket written by a teacher who attended a *Crosscutting Concepts* workshop. With this as the foundation of our program design, we have served hundreds of local teachers and thousands digitally across the country—and you can, too! ■

**Kathryn Danielson** (kdanielson2@gmail.com) is a program specialist at *Beyond, a design and technology ideas company*, in San Francisco, California. **Clea Matson** (cmatson@calacademy.org)

# Teaching Teachers.

is a senior associate of teacher professional development at the California Academy of Sciences in San Francisco, California.

## References

- Brunsell, E., D. Kneser, and K. Neimi. 2014. *Introducing teachers and administrators to the NGSS: A professional development facilitator's guide*. Arlington, VA: NSTA Press.
- Duncan, R., and V. Cavera. 2015. DCIs, SEPs, and CCs, oh my! Understanding the three dimensions of the NGSS. *Science and Children* 53 (2): 16–20.
- Greenemeier, L. 2013. *Scientific American*. Space Station Astronauts to Test 3-D Printing in Microgravity. August 26. [www.scientificamerican.com/article/microgravity-iss-3d-printing-space](http://www.scientificamerican.com/article/microgravity-iss-3d-printing-space)
- Holmlund Nelson, T., L. LeBard, and C. Waters. 2010. How to create a professional learning community: Make your experience worthwhile with these guidelines. *Science and Children* 47 (9): 36–40.
- NGSS Lead States. 2013. *Next Generation Science Standards: For states, by states*. Washington, DC: National Academies Press.
- Short, J. 2014. How Can Museums Help

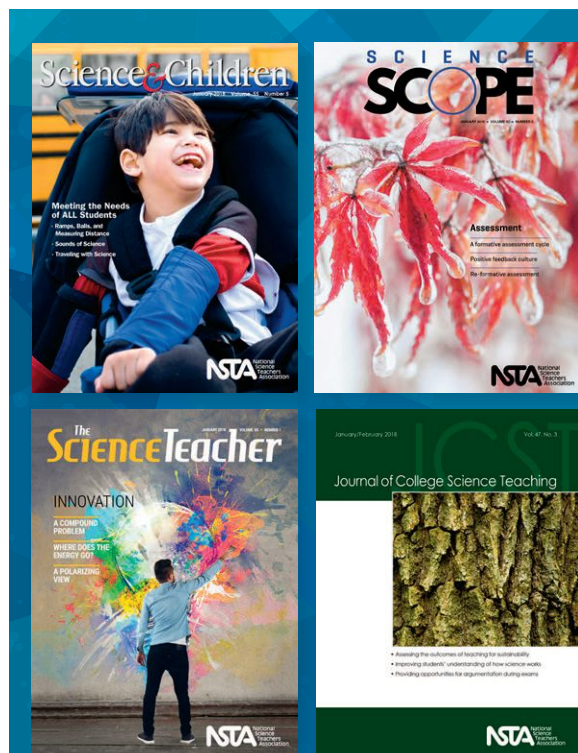
Teachers with the *Next Generation Science Standards*? Dimensions 16: 27–31.

## Internet Resource

NGSS Demystified  
[www.calacademy.org/educators/ngss-demystified](http://www.calacademy.org/educators/ngss-demystified)

## NSTA Connection

Download detailed instructions for carrying out the workshops at [www.nsta.org/SC1803](http://www.nsta.org/SC1803).



## #onlyatNSTA

Did you know there is a **journal archive** with over 4,000 articles from NSTA's award-winning journals? It's part of your member benefits!

Access through the Science Store at [www.nsta.org/store](http://www.nsta.org/store)

Join the conversation on Twitter and share your **#onlyatNSTA** moments with us. **@NSTA**

Learn about all your membership benefits at [www.nsta.org/membership](http://www.nsta.org/membership)

**NSTA** National Science Teachers Association