Learning About Professional Learning for NGSS

Hilleary Osheroff, Julie Yu, & Kristina Yu

exploratorium®
the museum of science, art and human perception

Project Goals

The Digital Teaching Boxes program for middle and high school life science teachers was designed to bring content related to health and biomedical research to students in support of implementing the Next Generation Science Standards (NGSS). This program brought together the expertise of the Exploratorium, research scientists, and life science teachers to work in small collaborative groups, mentoring one another as they assembled resources and developed curriculum materials. Workshops in the program covered a broad range of life science content, from cell biology to genomics to human evolution.

Digital Teaching Boxes were modeled after the physical teaching boxes that teachers have been creating for over 20 years at the Exploratorium Teacher Institute. Teaching boxes have everything a teacher needs to teach a curricular unit or series of lessons, and serve as a planning tool for professional development.

Over the course of this project, we aimed to answer the following questions:

- What professional development experiences are necessary for teachers need to implement the Next Generation Science Standards in their classrooms?
- How can informal science institutions and the research community best help with NGSS implementation?

Main Findings

We found, based on surveys and interviews with teacher participants:

- Teachers must experience first-hand the same phenomena-based learning opportunities that their students. Then, teachers need to be given time and space to make sense of that learning experience and re-engineer it for their own students. Informal science education institutions can provide these experiences and collaborative space.
- While stand-alone classroom resources such as hands-on activities, videos, and readings are valuable, to shift pedagogy towards NGSS requires teachers to focus on coherence and sequencing of activities: why and how each activity supports students asking and answering questions to explain and understand a natural phenomenon. Teachers require special supports for lesson planning from this perspective.
- Research scientists can provide a valuable resource to teachers in modeling real-life use of the Science and Engineering Practices, one of the three dimensions of NGSS.

Scientists Supporting NGSS Implementation

Over the course of this project, we have developed several design principles to maximize the impact of incorporating research scientists as guests presenters in an NGSS learning environment. These design principles leverage the unique ways that researchers are positioned to contribute to phenomena-based, inquiry-rich learning outlined in the NGSS.

- **Familiarize scientists with the basics of NGSS** prior to classroom visits, and leverage their unique strengths by focusing on the **Science and Engineering Practices** used in their research.
- **Identify content connections to Disciplinary Core Ideas**, and make these connections explicit to students with **hands-on activities prior to exposure to current research**
- Ground research **in phenomena-based experiences**, such as **first-hand observations** of model systems or organisms. Encourage scientists to bring physical artifacts and experiences when possible, and to ask audiences to make their own observations of phenomena. Design experiences so that participants can **engage directly with data.**

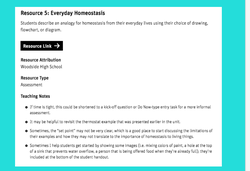
What Supports Do Teachers Need to Plan for NGSS?

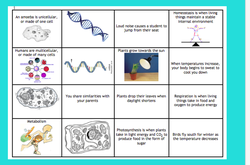
Digital Teaching Boxes 1.0: What classroom resources are needed for NGSS implementation?

The course of the Digital Teaching Box project aligned with the adoption and launch of NGSS in California. In the first years of implementation, teachers, schools, districts, professional learning providers like the Exploratorium, and other stakeholders began to interpret the standards into classroom practice. Our initial hypothesis was that a focus on the Science and Engineering Practices (SEPs) would be a high-leverage practice for teachers, and that the inspiration of the practices of working scientists might help teachers to create new NGSS-aligned resources for their classrooms. We carried out this approach over the first several years of Digital Teaching Box workshops, integrating research scientists into life science workshops. Scientists' research inspired Exploratorium-led classroom activities, and teachers used workshop time to assemble digital resource collections for use in their own classrooms. Teachers annotated these collections with notes on implementation for other teachers' use, with the intention of creating sharable and adaptable stand-alone resources.

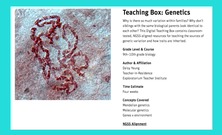
An example of this approach is the Homeostasis and Traits of Life Digital Teaching Box, created by a teacher in the 3rd year of the project. This teacher described her process in assembling this teaching box: *"Back then, it was a lot of what made sense to me in my mind but there were no attached phenomena, and I didn't really think about, 'what are the SEPs that students are going to be using for each of these activities?' and 'am I giving students a breadth of SEPs and cross-cutting concepts?' None of that was in my planning process at all."* We learned from teacher experiences like these that planning for NGSS implementation required more than inspiration, modeled experiences and a review of the standards.

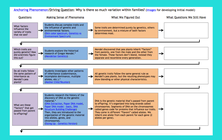
Furthermore, when other teachers reviewed and assessed previously-created Digital Teaching Boxes for their own classroom use, they appreciated the content and teaching notes, but the resources were so specifically designed for a particular course, teachers did not feel that they were easily applicable to their settings.





Digital Teaching Boxes 2.0





The teacher in the above example subsequently created a second Genetics Digital Teaching Box during a year as a Teacher-in-Residence at the Exploratorium. This teaching box had a similar format to her first, but had significant differences:

- It was explicitly designed around explaining a phenomenon (in this case, the similarities and differences between siblings of the same parents) .
- The sequence of activities was guided by the principle that each activity in the teaching box led to students figuring out this phenomenon. For each activity, she asked *"what have the students figured out from this activity and what questions are they still going to have, and then what activities should come next to address those questions?"*
- This teaching box was a more time-intensive process than her first, and was highly collaborative, with inputs from Teacher Institute educators, scientists, and teachers.

For this teacher, her experience pinpointed the challenge of NGSS. The vision of NGSS relies less on stand-alone, NGSS-aligned classroom resources, and more on how a resource is used to challenge students to use the SEPs to ask and answer questions. In response to these findings, we moved towards creating broadly applicable tools to support teachers in answering the question:

How are classroom resources sequenced and framed so that asking and answering questions guides the learning process?

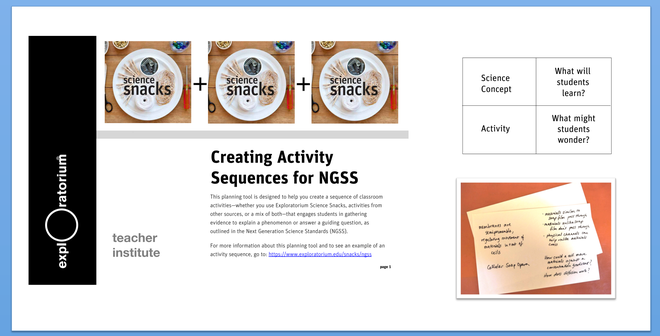
Planning for Student Questions: a Sequencing Tool for Teachers

We have changed the 'why' we do it. – Teacher Leader Participant

To support teachers in designing classroom experiences in which students truly have the opportunity to "figure something out," we developed a simple planning tool to help teachers create instructional sequences that center students' observations and questions. Single activities in which students use the Science and Engineering Practices to construct knowledge about content are the raw material for an NGSS-aligned lesson.

This sequencing tool can be used to plan a single lesson or an entire semester of instruction and prompts teachers to look at classroom activities through the lens of the student. Activities are sequenced based on the questions raised or unanswered by previous activities, so that anticipated student observations and questions determine how learning unfolds.

Teacher Institute staff created sample sequences to serve as models, focused on biological examples, such as the Osmosis sequence above.



The sequencing tool was tested and refined in a statewide professional development workshop with teacher leaders who work in schools and districts across California, all of whom support other teachers in NGSS implementation. One TL said, "I loved this tool… I think it will really help teachers feel like they can take their ideas and apply them to the standards. It models how the same activities can teach such varying ideas."

By shifting from stand-alone resources to tools that support teachers to revise their own curricula, this professional learning approach mirrors the vision described by NGSS—helping teachers to design their own solutions to individual questions around the lessons they teach.

SEPA SCIENCE EDUCATION PARTNERSHIP AWARD
Supported by the National Institutes of Health

This project was supported by the Office Of The Director, National Institutes of Health under Award Number R250D016525.
The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.