Getting started with the Next Generation Science Standards

A primer and resource guide for afterschool educators

Afterschool Alliance

afterschoolalliance.org

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Thanks to the following partners for lending their time and expertise to help refine this guide:

NJSACC
The Statewide Network for
New Jersey's Afterschool Communities

ExpandEDSchools by TASC

Vermont Afterschool
Partnerships, Advocacy, Training, and Resources for Excellence in Afterschool

Introduction

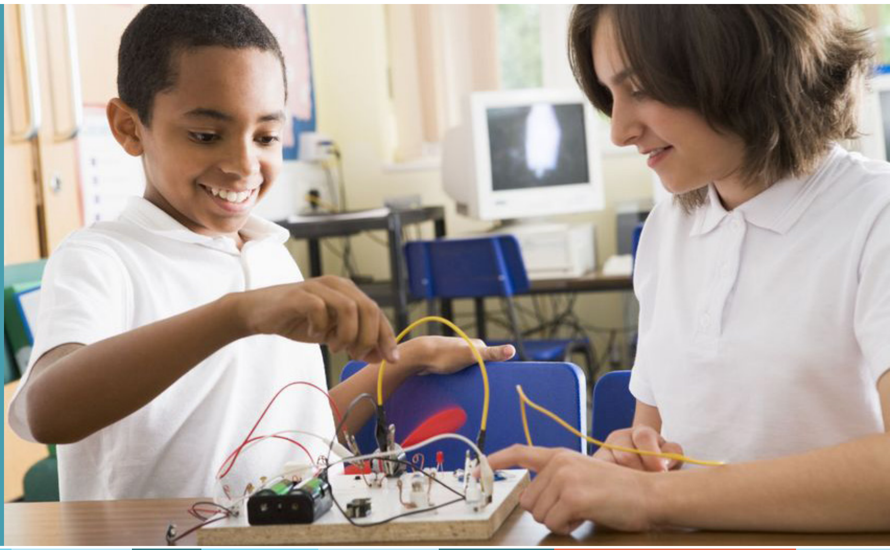
The Next Generation Science Standards (NGSS) offer a new vision for K-12 science education that reflects how real-life scientists and engineers practice their craft. This means students learn by doing—observing clouds to understand weather patterns, exploring electricity with circuits, or designing a prosthetic hand to help someone in need. This fits beautifully with the afterschool field's preference for teaching science, technology, engineering, and math (STEM) through hands-on activities and experiential learning! Additionally, NGSS supports the development of 21st century skills in students, a goal of many afterschool educators.

NGSS brings long-needed reforms to national and state K-12 science education standards, incorporating decades of new research on how students best learn science, and reflecting the many recent advances in knowledge made within the science disciplines. The intent is that all high school students, upon graduation, are able to apply the processes of science and engineering to daily life, become critical consumers of STEM information within the public sphere, and have the ability to go into careers of their choice. State and national experts in K-12 science education, higher education, industry, and professional scientists collaboratively developed NGSS so that it could achieve these diverse goals. NGSS is aligned with Common Core, both in Math and English Language Arts.

NEXT GENERATION SCIENCE STANDARDS
For States, By States

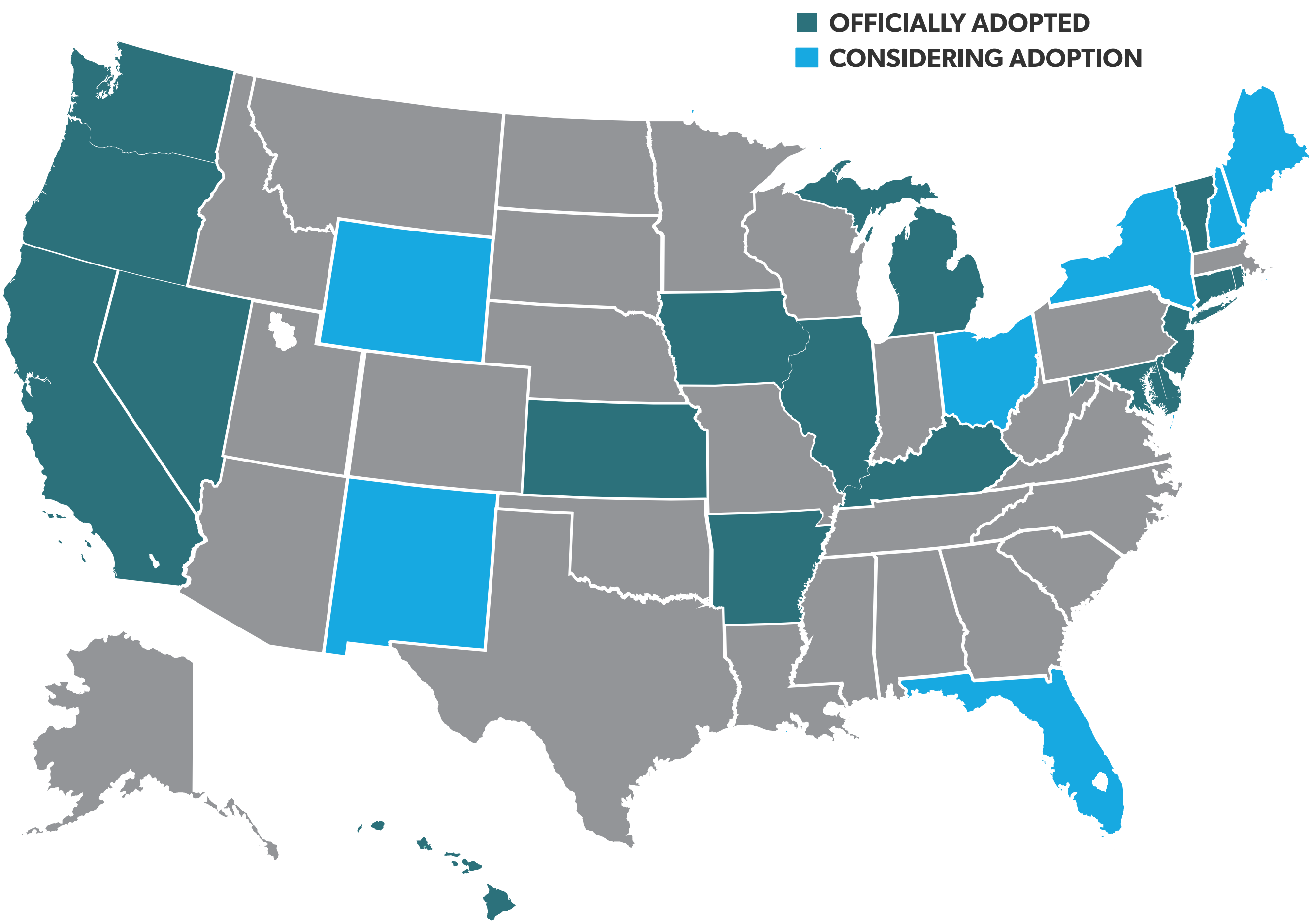
The inclusion of engineering as a core component of the standards represents a significant shift in science education, as engineering can be understood as the application of science. To reflect the growing recognition of the importance of computer science education, NGSS also includes elements of computational thinking or the problem-solving process specific to computer science.

The goal of this document is to help afterschool practitioners understand how NGSS' content was developed and organized, a few challenges that schools and districts are facing, and the opportunities that NGSS provides to afterschool programs. We point to several resources that can help practitioners dig deeper into the standards and start planning how their next steps. Keep in mind that many education organizations are actively working to develop additional support resources and promising practices, both for school-day teachers and out-of-school time educators. The Afterschool Alliance will do its best to bring appropriate NGSS tools and knowledge to the afterschool field!



NGSS Across the Nation

As of July 2016, 17 states and the District of Columbia have adopted NGSS and are in varying stages of implementation. Seven additional states are officially considering adoption. Locally, many districts and schools have taken steps to implement NGSS, regardless of their state's adoption status. Current news and information on state adoptions can be found at the National Science Teachers Association (NSTA) and the National Association of State Boards of Education (NASBE) websites.



OFFICIALLY ADOPTED

1. Arkansas
2. California
3. Connecticut
4. District of Columbia
5. Delaware
6. Hawaii
7. Illinois
8. Iowa
9. Kansas
10. Maryland
11. Michigan
12. Nevada
13. New Jersey
14. Oregon
15. Rhode Island
16. Vermont
17. Washington

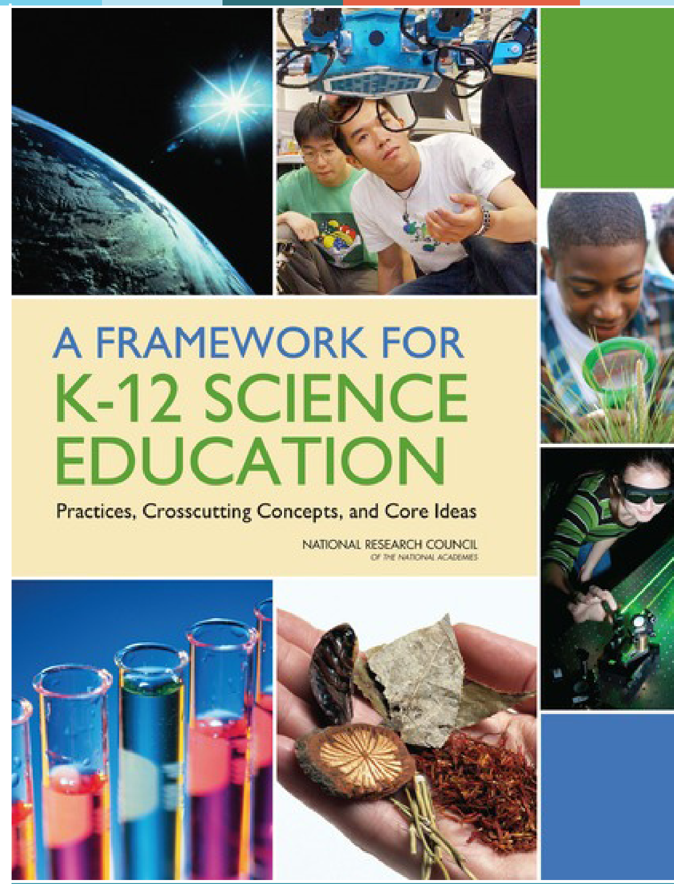
CONSIDERING ADOPTION

1. Florida
2. Maine
3. New Hampshire
4. New Mexico
5. New York
6. Ohio
7. Wyoming

Who Developed NGSS?

Four extremely well-regarded groups—the National Research Council, the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve, Inc.—led a collaborative effort among 41 writers with expertise in science and science education. These writers were in turn guided by 26 state teams, each with 50 to 150 members. Members of the state-level teams included: K-12 teachers, college and university faculty, and science and engineering workforce experts. After the first draft of the standards was complete, it was opened to the public for review and revised twice. The final standards were published in 2013.

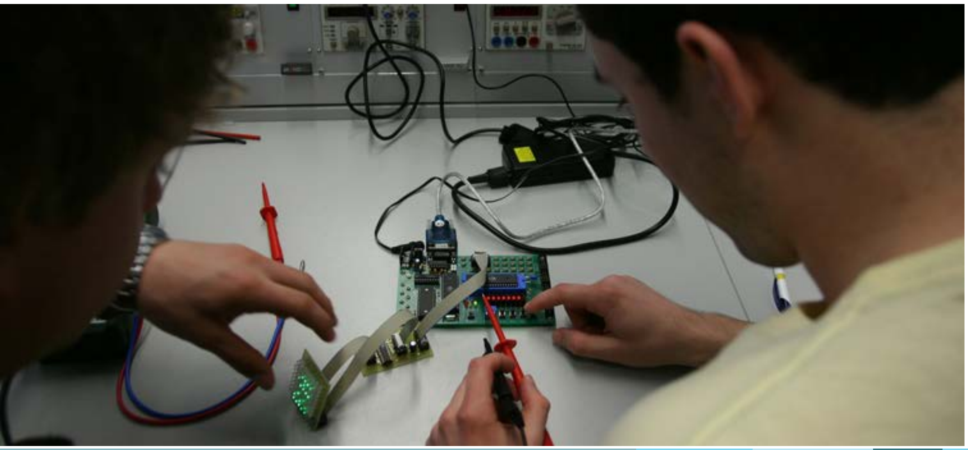
The 2011 consensus report, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (hereafter referred to as the *Framework*), provides the evidence-based foundation for NGSS—it draws on contemporary research on effective science education, and identifies the science content students should know, pulled together in a way that builds coherent understanding over time. The *Framework* was produced by the National Research Council's Board on Science Education.



Read this!

A Framework for K-12 Science Education is key to understanding the significant changes to teaching STEM represented within NGSS.

Download a free copy.



Overview of the Standards

NGSS is built on the foundation that science learning is comprised of three dimensions: (1) science and engineering practices, (2) cross-cutting concepts, and (3) disciplinary core ideas. The intention is for all three to be woven together when developing activities and teaching students, as well as to be addressed at each grade level. For full descriptions of each aspect of the dimensions, read Chapters 3 through 8 in the *Framework*. You can also check out BozemanScience.com for short explanatory videos.

Dimension 1: The Practices

NGSS outlines eight science and engineering "practices" which encompass both the skills and knowledge required to do real science and engineering work (read Chapter 3 of the *Framework*). Learning science and engineering by engaging in the practices helps students understand how scientific knowledge develops and real-world engineering problems are solved. It exposes youth to relevant and current topics, and necessitates that they do hands-on, experiential or project-based learning. Additionally, math is embedded within several of the practices, providing context and motivation to build math skills like measurement, arithmetic, and statistics.

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Dimension 2: Cross-Cutting Concepts

Within every science topic, whether it's chemical reactions, the human body or the solar system, you'll find an underlying set of big ideas that cut across science disciplines. For example, the concept of "scale" is relevant to understanding the relationship between atoms and molecules in chemistry, learning about cell structure and function in biology, and grasping the size of the universe when studying astronomy. NGSS includes seven of these "cross-cutting concepts" which show up in each grade, and in multiple disciplines (read Chapter 4 of the *Framework*). Educators are encouraged to explicitly call out the cross-cutting concepts, as it provides students with familiar touchstones that help them develop a holistic, coherent of understanding of science and engineering over time.

1. **Patterns.** The patterns observed within events, structures and organisms guide organization and classification, and prompt questions about the relationships and factors that influence them.

2. **Cause and effect.** Events have causes: sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships, as well as how and why they happen.

3. **Scale, proportion, and quantity.** Different phenomena are relevant at different measures of size, time, and energy.

4. **Systems and system models.** Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

5. **Energy and Matter.** Understanding how energy and matter flow into and out of cycles, and how the two are conserved within systems, helps one understand the systems' possibilities and limitations.

6. **Structure and function.** The way an object or organism is shaped can determine its properties, functions and behaviors.

7. **Stability and change.** What drives change or stability in systems, both natural and manmade, is important to study.

Dimension 3: Disciplinary Core Ideas

The goal of NGSS is not to teach "all the facts", but rather to provide students with sufficient knowledge under the expectation that they'll learn how to go out and access new information themselves. The content topics within the four disciplinary core ideas provide focus, with the acknowledgement that many topics overlap among disciplines. Again, content within each discipline builds coherently on previous years, from kindergarten through grade 12. Educators should be aware that NGSS explicitly includes topics such as climate change and evolution that are deemed controversial in non-scientific circles. For help in addressing these topics, explore resources from the National Center for Science Education.

1. **Physical sciences** – matter; force and motion; energy; waves (Chapter 5 of the *Framework*)
2. **Life sciences** – structure and processes of organisms; ecosystems; heredity and inheritance; biological evolution (Chapter 6 of the *Framework*)
3. **Earth and spaces sciences** – Earth's place in the universe; Earth's systems; Earth and human activity (Chapter 7 of the *Framework*)
4. **Engineering, technology and applications of science** – engineering design; links between engineering, technology, science and society (Chapter 8 of the *Framework*)

Attending to Equity and Engaging Underrepresented Populations

NGSS' Appendix D, All Standards, All Students, and the companion case studies provide additional information to help ensure that all groups underrepresented in STEM are reached effectively, including girls, racial and ethnic minorities, economically disadvantaged students, English language learners, and students with disabilities. For more on how educators can promote equity STEM education, see these briefs:

- How can we promote equity in science education? (STEM Teaching Tools, 2015)
- Teaching STEM in ways that respect and build upon Indigenous Peoples' rights (STEM Teaching Tools, 2015)
- Engaging English learners in the science and engineering practices (STEM Teaching Tools, 2014)

Performance Expectations

The grade-level standards within NGSS are framed as "performance expectations," focusing on what students should be able to do, rather than a set of facts that should be memorized. Again, this reflects NGSS' focus on the practices of science and engineering. Performance standards are mapped to the practices, disciplinary core ideas, and cross-cutting concepts that they contain. Explore the complete standards here: www.nextgenscience.org/search-standards.

An example from third grade

Throughout the year, third grade students will touch on four different Disciplinary Core Ideas, each with three to four performance expectations:

1. Forces and Interactions (Physical science)
2. Relationships within Ecosystems (Life science)
3. Life Cycles and Trait Inheritance (Life science)
4. Weather and Climate (Earth and space science)

One task third grade students will be expected to demonstrate is: [The ability to] ask questions to determine [the] cause and effect relationships of electric or magnetic interactions between two objects (3-PS2-3 Motion and Stability: Forces and Interactions). Every performance expectation is accompanied by a "Clarification Statement" such as the following, which gives concrete examples of electric and magnetic forces, as well as some relationships to explore:

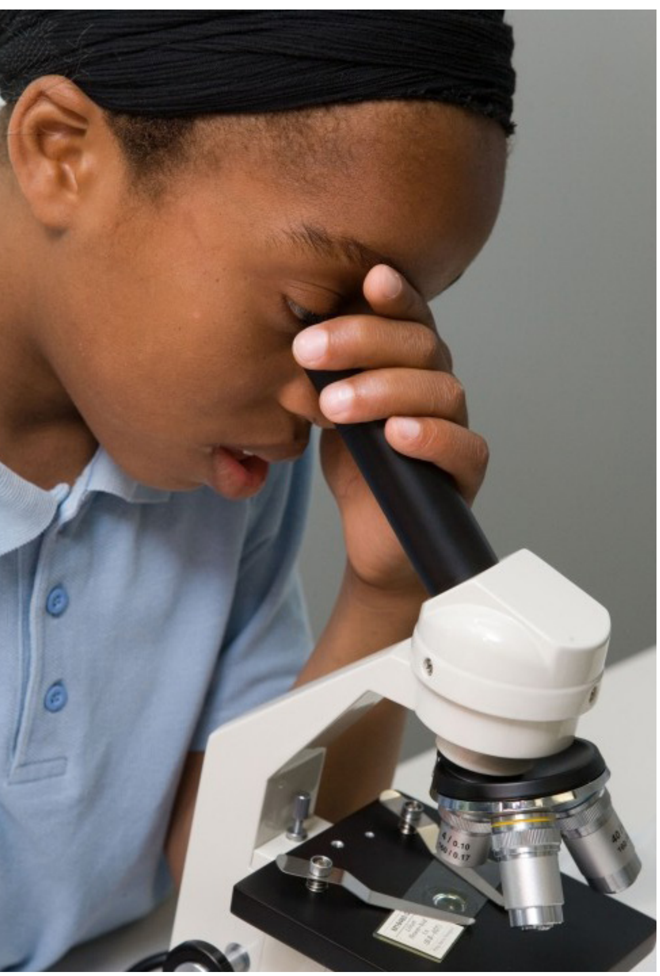
- *Examples of an* **electric force** *could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper*
- *Examples of a* **magnetic force** *could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets.*
- *Examples of* **cause and effect relationships** *could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.*

Reading this Clarification Statement might spark an idea of a how to introduce kids to the concepts of electricity and magnetism, and help them build on the science practices of asking questions and carrying out investigations. For example, this hands-on activity from the Exploratorium's collection of Science Snacks takes kids through an open-ended exploration of static electricity with balloons and other objects. Afterschool educators might then research other related activities to build out a sequence of lessons that supports this particular performance expectation or the three other related expectations under third grade Force and Interactions. In planning for the year, afterschool programs might check in with the schools their students attend to see when teachers are planning on covering this topic, and identify activities, curriculum, or other learning opportunities that might support and or enhance student learning.

While much of the public discourse around NGSS is geared towards reforming school-day STEM education, the standards can help all educators better understand what effective science education looks like. For afterschool educators, this means an opportunity to elevate their professional competencies in STEM education. However, as afterschool programs aim to complement the school day without replicating it, we need to consider the unique niche that afterschool programs occupy in STEM learning. A recent NRC report names three criteria for high-quality STEM learning in afterschool:

1. Afterschool programs provide **first-hand experiences** with phenomena, concepts, and practices that are both intellectually and socio-emotionally engaging;
2. They **recognize and build** on young people's interests, prior experiences, and cultural resources, which vary across communities; and
3. They **actively make connections** to STEM ideas and experiences in school, at home, and in future learning and work opportunities.

Moving forward, we must design afterschool STEM programs with these characteristics, which leverage the strengths of the field and our students' capacities, while supporting, expanding, and deepening the vision for STEM education outlined in NGSS.



Where Does Afterschool Fit In?

Working with schools and districts

Implementation of NGSS will require big changes for teachers and schools. Teachers will need to learn new pedagogies and skills to support NGSS' performance expectations, as well as additional content knowledge that allows them to go more in-depth on topics. Schools will need to allow for increased collaboration across departments and among teachers, and find ways to provide more classroom time for science. These demands require new ways of training current teachers and providing on-going professional development, new approaches to pre-service teacher education, revamped state science assessments, and more—all of which will take several years to phase in. Additionally, with the new national education law signed by the president in December 2015, the *Every Student Succeeds Act* (ESSA), states and districts have a lot to consider and are actively working on a plan to comply. Furthermore, ESSA brings some major changes in regards to STEM education. To address these coming challenges, there is an increasing recognition that effective NGSS implementation requires concerted efforts by multiple K-12 education stakeholders. The afterschool field can strategically position itself as a key partner in helping schools and communities achieve the new vision for science education. Make a strong case for collaboration and partnership with the California AfterSchool Network's talking points, *Collaborate to Innovate*.

Additional Reading:

- Identifying and Supporting Productive STEM Programs in Out-of-School Settings (National Research Council, 2015)
- What is the role of informal science education in supporting the vision for K-12 science education? (STEM Teaching Tools, 2015)
- The Guide to implementing the Next Generation Science Standards is written for schools, though it touches on the role that community partners, such as museums, science centers, zoos, aquariums and afterschool programs can play in meeting implementation goals. (National Research Council, 2015)
- Supporting the implementation of NGSS through research: Informal science education (National Association for Research in Science Teaching, 2014)

Your Next Steps

1. Get to know NGSS better

- Look through the standards themselves! Explore an interactive version here, as well as an ever-growing collection of support resources: www.nextgenscience.org
- Don't miss the appendices to NGSS, which includes deeper explanations of its goals and themes.
- Read the Framework for K-12 Science Education, which provides the evidence base for the overall philosophy, content, and structure of NGSS.
- Find out how other afterschool programs are approaching NGSS and learn together! This can be a great opportunity to start up a Community of Practice if there isn't already one in your area.

2. Reflect on how your goals in STEM education align with NGSS

- Click2SciencePD, an online STEM professional development resource for out-of-school providers, outlines "20 Skills that Make STEM Click" which infuse youth development principles with STEM learning. They've cross-walked these 20 skills with both NGSS and Common Core.
- Socio-emotional learning (SEL) is another focus of the afterschool community. FUSE: Next Generation outlines promising practices for support SEL within STEM, and how to align NGSS principles more cohesive ways in both formal and informal settings.

3. Seek out professional development to improve practice

- Bozeman Science, run by science education expert Paul Andersen, has a short YouTube video explaining every one of the science and engineering practices, crosscutting concepts and disciplinary core ideas
- STEM Teaching Tools is a collection of professional learning briefs that help educators understand a specific problem or issue related to implementing NGSS, reflect on it, and access resources and instructional tools that will enable them to teach STEM more effectively. From the Institute for Science + Math Education at the University of Washington.
- Check with your Statewide Afterschool Network or state affiliate of the National AfterSchool Association to see if they are offering any upcoming trainings. If not, let them know you're interested!

Aligning Activities and Curriculum to NGSS

Because NGSS does not specify curricula, you can theoretically choose any high-quality activity or curriculum that works best with your students and community resources to help students achieve a performance expectation. You may not need to purchase new "NGSS-aligned" curriculum—what you're already doing might fit, or could be adapted. However, adapting an existing practices can be a challenging task for afterschool educators without a STEM background, which highlights the need for an established set of criteria for high-quality afterschool STEM curriculum or a tool to help evaluate existing materials (similar to the EQuiP rubric developed for schools). In the meantime, check out the Afterschool Alliance's favorite activities for the out-of-school time environment.

- Science centers and museums often provide professional development for school day teachers. Ask if afterschool educators are welcome at these trainings, and if not, make the case for why you should!

- For professional development providers: The California Academy of Sciences' toolkit, NGSS Demystified, can help you prepare to lead a training session for educators. It includes presentation slides, talking points and hands-on activities.

4. Explore community partnerships

- **Schools and districts.** Use the California AfterSchool Network's talking points on NGSS and Common Core partnerships, Collaborate to Innovate, to make the case to schools and districts why afterschool programs are key partners.

- **STEM-rich institutions.** Think about other organizations that share a similar vision for STEM education within your community—like science centers and museums, zoos and aquaria, parks and nature centers, or universities and community colleges. These organizations can of course make great partners, but they also may offer additional STEM learning opportunities that your students can plug into. Research shows that it's important to both provide a pathway of learning through the grades and connect students' learning between school, out-of-school, and home settings.

- **STEM education stakeholders.** Use NGSS as an opportunity to forge relationships with other K-12 STEM education stakeholders—connect with a STEMx network, ask your local chamber of commerce if they have a workforce committee, and find out if there's a STEM Ecosystem initiative in your area.

For more resources on STEM and afterschool
visit **afterschoolalliance.org/STEM**

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