EXPLORE SCIENCE

TRAINING MATERIAL

Zoom into Nano

Science Outside of School

Science Outside of School

The Explore Science kit provides a great opportunity to do hands-on science, or STEM, in out-of-school settings. “STEM” stands for Science, Technology, Engineering, and Math:

Science is knowledge about the natural world, learned through experiments and observation

Technologies are tools, machines, and equipment that have a practical use

Engineering is the use of science to create useful things or structures

Mathematics is the science of numbers

Scientists study nature, while engineers take scientific knowledge and use it to make technologies. Math is a special kind of science that focuses on numbers—and it’s also used in all fields of science and engineering. In the Explore Science kit, we often just refer to “science” to keep things simple, but it’s good to remember that science is closely related to technology, engineering, and math.

STEM activities help people understand the natural world, and to identify and solve problems. The things we discover and the things we create change the way we live—and the way we live affects the kinds of questions we investigate and the technologies we decide to develop.

People can choose to study STEM and have careers in areas directly related to STEM. You can enter a STEM career in different ways: through vocational training, through a two-year or four-year college degree, or through an advanced degree. Scientists do STEM in labs, but they can also work in outdoor research stations, farms, factories, hospitals, veterinary clinics, and parks.

You don’t have to be a professional scientist or engineer to use STEM knowledge and skills. We use STEM in every aspect of our lives. People use STEM skills when they’re at home cooking, at work using a computer, at the store deciding on the best deal for their money, outside noticing the weather, or while playing sports or video games with friends.

Learning science outside of school

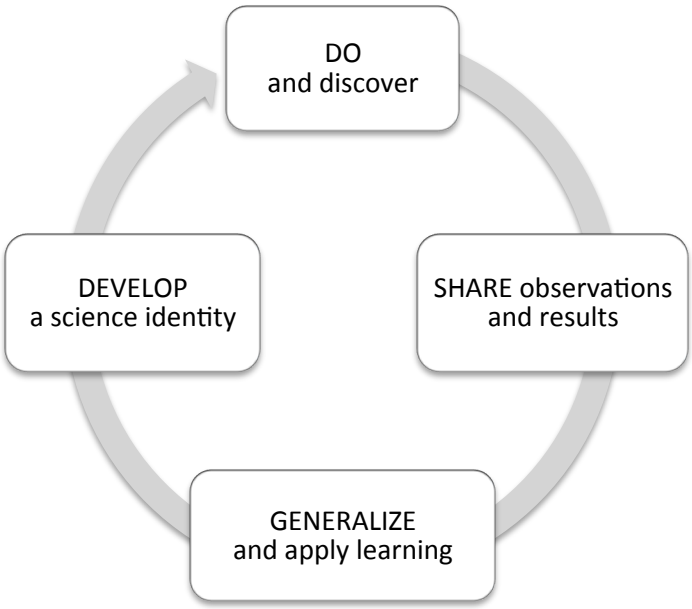
Doing hands-on science activities outside of school can encourage a lifelong love of learning, motivate learners to explore and discover new things, and help them to connect abstract concepts to the real world. Learning STEM out of school gives students another chance to learn material and make connections to other interests and subjects. Hands-on science supports youth development by offering challenging activities, providing opportunities to get involved, and fostering positive social relationships.

Science outside of school might be different from your experience of science in school.

Successful out-of-school-time STEM activities spark and satisfy natural curiosity, letting learners figure things out for themselves. They're hands-on, fun, and accessible, and offer safe, age-appropriate challenges for diverse learners. Hands-on science activities can also provide a variety of ways to explore and be creative. Science outside of school can also connect to the real world and the community, making it more relevant for learners.

Learning by doing, or *experiential learning,* is the most effective way to learn and enjoy science outside of school. As facilitators, our goal is to help learners do the activities themselves and create meaningful connections to other things they know and care about.

Experiential learning cycle:



Leading hands-on science activities

The Explore Science kit is designed for learning by doing. The activities and materials are safe, appropriate, and fun for a broad range of learners. The activities are all thoroughly tested with educators and kids, so you can feel confident that you can facilitate them successfully.

Each activity is structured to follow the experiential learning cycle. As you do Explore Science activities with learners, there are many things you can do that will help create great learning experiences. Here, we go through some tips, relating them both to the experiential learning cycle and the structure of the Explore Science activities.

Develop a science identity

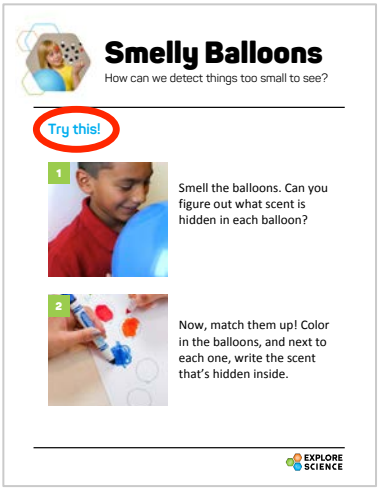
Hands-on science activities can help learners feel confident and interested in science. When a person feels that he or she is someone who can do science, that sense of identity helps them succeed in science classes in school and consider careers related to science, engineering, and technology.

There are many things you can do to help learners develop a science identity:

- Recognize and reinforce the idea that everyone can do STEM. That includes learners of different ages, genders, backgrounds, personalities, and abilities. (It also includes you!)
- Help to generate and sustain learners' motivation and engagement. Present STEM activities as a fun opportunity and encourage everyone to participate. Be excited about doing the activities yourself—that will help learners stay motivated and interested.
- Avoid stereotypes about who likes science, is good at science, or becomes a scientist. Make sure potential participants don't exclude themselves from science activities based on preconceptions about science.

Do and discover

Experiential learning is the most effective way to learn and enjoy science. People learn science best if they try things for themselves, and make a discovery.



The activity guides include a section called "**Try this!**" which provides clear instructions in words and pictures. You might choose to demonstrate some of the steps, and then let learners use their guides for reference. All the steps are included on the front side of the guide.

Try this! corresponds to the **Do and discover** stage of the learning cycle. At this stage, you can support learning by:

- Providing clear instructions—but letting learners do the activity themselves. Try not to over-supervise or direct.
- Letting learners experience and discover. Don't give away the results or the surprise of the activity before they do it!
- Asking open-ended questions that encourage learners to make predictions, think ahead, plan, and analyze what they're doing. For example, you can ask "What do you think will happen when you . . . ?"

- Avoiding telling learners what they "should" do, but do offer hints and suggestions about things they might notice or try if they are stuck.

Share observations and results


Tiny scent molecules are leaking out of the balloon. They're too small to see, but you can smell them!

What's going on?

Scent molecules are so small that they can travel through the balloon. In fact, they're so tiny that they're measured in nanometers!

A nanometer is a billionth of a meter. That's very, very small—too small to see with just your eyes. We can use our sense of smell to explore the world on the nanoscale, because we can smell some things that are too small to see.

Your sense of smell works by identifying the shape of scent molecules. Molecules are made of atoms bonded together. Everything in the world is made of atoms, including the balloons and the scented air inside them.

How is this nano?

Nanotechnologies include new materials and tiny devices so small they're sometimes built from individual atoms and molecules!

For example, researchers are creating nano-sized sensors that can sniff out very small amounts of chemicals in the air. Some of them work the way your nose does, by detecting the different shapes of molecules in the air.

Nano-sized biosensor

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Learners need to make sense out of what they observe. Sharing what they notice and talking about why they think it happened can help them understand.

The activity guides include a section called "**What's going on?**" which explains what happens in the activity from a scientific point of view. You may choose to give learners a chance to describe, understand, and explain what's happening in their own way before providing this information. This section is on the back side of the guide, so you have the option to ask learners not to look at it until you're ready.

What's going on? corresponds to the **Share observations and results** stage of the learning cycle. At this stage, you can promote learning by:

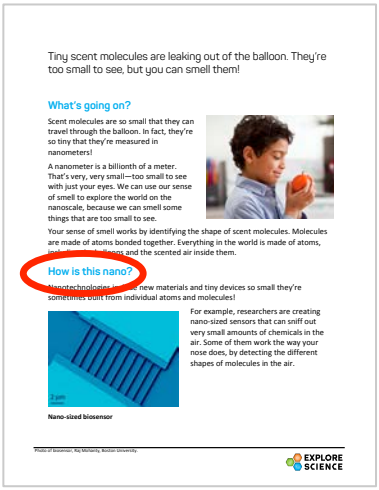
- Asking questions that help learners make sense of what they observe and explain their thinking. Good questions include:

  "What did you notice?"
  "Why do you think that happened?"
  "How do you know?"
  "What ideas do you have?"

- Modeling that it's ok not to know something—what's important is thinking about good questions and trying to figure out answers. If you're asked a question you don't know the answer to, you can say:

  "That's a good question! I don't know the answer. How do you think we could find out?"

Generalize and apply learning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Science is integral and important to everyday life, but sometimes it takes a little thinking for learners to see how. Learners will be more motivated to learn and understand science if they see how it connects to things they know or care about.

The activity guides include a section called "**How is this nano?**" which explains how the activity is connected to nanoscale science, engineering, and technology (or "nano" for short). This section also makes connections to other fields such as medicine, or to products or inventions related to the activity. You may choose to give learners a

chance to describe, understand, and explain what's happening in their own way before providing this information.

How is this nano? corresponds to the **Generalize and apply learning** stage of the cycle. At this stage, you can promote learning by:

- Asking open-ended questions that help learners make connections to things they've experienced before. For example, you can ask:

  "What does this remind you of?"

  "Where else could you use this?"

- Suggest ways that the activity relates to other things learners might be interested in or have heard about recently. For example, you might suggest how the activity relates to common interests for kids such as sports or animals, or to topics that concern adults such as community issues or career options for their children.

Resources

Nanoscale Informal Science Education Network

The Nanoscale Informal Science Education Network (NISE Net) is a national community of researchers and informal science educators dedicated to fostering public awareness, engagement, and understanding of nanoscale science, engineering, and technology. Nisenet.org is an online digital library of public nano educational products and tools designed for educators and scientists. In addition to the Explore Science kits, many more resources related to nano education and educator professional development are available on the project website. See more at http://www.nisenet.org/.

Afterschool Alliance

The Afterschool Alliance is dedicated to raising awareness of the importance of afterschool programs and advocating for more afterschool investments. They provide resources related to getting started with STEM, funding afterschool STEM programs, research on STEM learning, and more. See more at http://www.afterschoolalliance.org/stem.cfm.

Boys & Girls Clubs of America

Boys & Girls Clubs of America offers DIY STEM, a hands-on, activity-based curriculum that connects youth to science themes they encounter regularly. It is available for use by Clubs, other non-profit organizations, and the general public. See more at http://www.greatfutures.org/pages/TWC-DIYSTEM.aspx?_ga=1.28406005.891684769.1445954680.

Center for the Advancement of Informal Science Education

The Center for the Advancement of Informal Science Education (CAISE) provides InformalScience.org, a central portal to project, research, and evaluation resources designed to support and connect the informal STEM education community in museums and other learning environments. See more at http://www.informalscience.org/.

Click2Science

Click2Science is an interactive professional development site for trainers, coaches, site directors, and frontline staff/volunteers working in out-of-school-time STEM programs serving children and youth. It was developed by the UNL Extension in partnership with the Noyce Foundation and in collaboration with many other organizations. See more at http://www.click2sciencepd.org/.

How to Smile

Howtosmile.org collects the best science and math activities, designed especially for those who teach school-aged kids in non-classroom settings. The project is a collaboration of educators at science museums and children's museums. See more at http://howtosmile.org/.

National Girls Collaborative Project

National Girls Collaborative Project (NGCP) brings together organizations throughout the United States that are committed to informing and encouraging girls to pursue careers in STEM. NGCP offers many resources to strengthen collaborative networks and advance STEM education for girls. See more at http://ngcproject.org/.

4-H

4-H science programs create hands-on learning experiences to encourage young minds and help fill our nation's shortage of young leaders proficient in science, engineering, and technology. Their professional development tools build understanding and support implementation and evaluation. See more at http://www.4-h.org/resource-library/professional-development-learning/science-training-guides-resources/.