

I AM A SCIENTIFIC CITIZEN!!

Science is all about figuring “stuff” out – so that we understand our world better. Science helps us investigate questions and solve problems in just about every way imaginable. That is pretty cool! On this patch journey, you will learn about how science works, who scientists are, and why science matters. In doing this, you will test your science know-how, go on a real science adventure, and learn how to be a good scientific citizen throughout your life. So grab your pen and paper and let’s get started!



Activities

1. Check your “science know-how”
2. Observe and ask questions the way scientists do!
3. Get involved in a citizen science project
4. Share what it means to be a scientific citizen

Purpose: When I’ve earned this badge, I’ll know **how science works, who scientists are, and why science matters.**

Activity 1:

Check your science know-how with this Science Savvy Quiz

We learn a lot about science when we are at school, but often we don't recognize the science that is happening all around us, or how science really works.

See what you know: Share your understanding of science by answering the questions below. For each statement, put a "T" next to all the responses that are true and an "F" next to all the responses that are false.

Science is:

- just a collection of facts found in books.
- a way to discover new information and investigate questions about the natural world.
- very creative.
- only for super smart people.

Which statement(s) are true about scientists:

- They know all the answers, and don't need to ask for help.
- They ask questions, then figure out how to answer them.
- They talk to other scientists to learn more about their questions.
- They share what they learn with other scientists by writing down what they discover, publishing them in a journal, and/or giving a presentation to colleagues
- They always think the same thing. They never disagree.

When scientists do science:

- they follow an easy five step recipe: Ask a question, form hypothesis, perform experiment, collect data, draw conclusions.
- they are sometimes surprised by their results.
- everything always goes according to the plan.

At the end of the scientific process:

- science is done.
- more questions always emerge.
- scientists have learned something, even if the results are not what they expected.
- the scientific process doesn't end.

To be a scientist:

- you have to be a man.
- you have to be creative and enjoy asking and answering questions.
- you can be anyone from anywhere.

Science:

- creates information that helps us solve problems.
- helps us understand how our world is changing.
- is not very useful to ordinary people.
- only takes place in laboratories.
- takes teamwork.
- leads to more questions.

Watch an example of science in action: After completing the quiz watch this video showing an example of science as it is really happens:

<http://www.calacademy.org/sciencetoday/how-science-works/559179/>

Reflect back on your quiz: How did your understanding of how science is done change after watching the video? Update your answers to the quiz when you learn something new!

What is your science savvy score? Count your score to tally how savvy you are about how science works.

Correct responses:

20-25: Correct response: Way to go! You're ready, Let's go do some science!

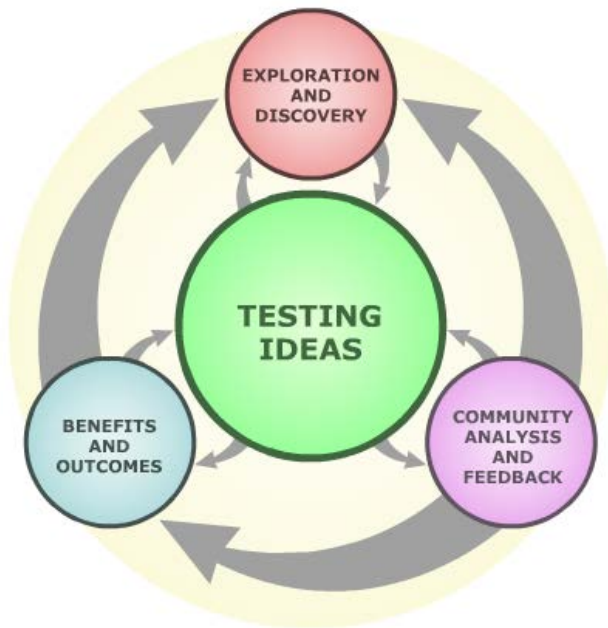
12-19: Hello scientist-in-training! You are on your way to understanding how scientists investigate our world... keep up the great work!

0-11: Try watching the video again with a friend to make sure you understand how science works. Discuss the answers you missed and look for clues in the video to find a better response.

Discuss: Once your troop or group is ready, discuss the answers that you changed after watching the video. What new things did you learn? What answers did you change? What surprised you? What do you still want to know?

Did this question trick you? *Scientists follow an easy five step recipe: Ask a question, form hypothesis, perform experiment, collect data, draw conclusions. This one tricks a lot of people because it is what our textbooks focus on in school.*

This image is a new way to help us think about how science *really* works.



Schoolbooks often focus on conducting an experiment, but science is SO much more. Did you notice that the scientists in the video did not go to the lab to conduct a formal experiment? They found a new spider and wanted to know what it was. They used microscopes to look closely and compare what they were looking at (the new kind of spider) to what they knew (all the other spiders in their collections and books). They spoke to one another to discuss how to proceed in their investigation. They actually found out that their first ideas were wrong! That is not unusual in science!

Scientific citizens talk about science in a very different way. Not just how it is done, but what it means for people and society.

How Science Works: Science is a journey: exciting, creative, dynamic, and sometimes unpredictable. Science is a blend of logic and imagination. Science informs-- it doesn't impose. Science belongs to everyone.

Why Science Matters: Science is a tool everyone can use. Science empowers us to answer questions and helps us solve problems, big and small.

Who Scientists Are: Scientists are people from all walks of life who enjoy the process of discovery. With training and participation in the scientific community, anyone can become a scientist.

Activity 2: Begin your own science investigation

Exploring and Discovering

Science is both a body of knowledge and a process. Sometimes science may seem like a collection of isolated and static facts listed in a textbook, but that's only a small part of the story. Just as importantly, science is also a process of discovery that allows us to use what we know to understand what is going on around us. **Exploring the natural world requires different types of skills, like those presented in the Science Flow chart. For this activity, you will begin by practicing your observational skills!**

What you should bring along for your adventure:

- _ Notebook
- _ pen/pencil
- _ hand lens/magnifier
- _ ruler
- _ ziploc bag

Pick your field site:

No matter where you live, there are always places to explore and things to wonder about. Head outside to a place you like to visit – preferably one that is not too crowded. It could be a park, a nearby beach, a creek or river, or even your backyard! Set aside about an hour on your first day and a little longer on the second day.

We have encouraged you to pick a field site that is outside, because there are so many things to observe and explore there, but there are just as many science opportunities awaiting you indoors as well!

We learn to observe by practicing – just like riding your bike, playing the piano, or cooking! Your field site is where you will practice observing, let's get started!

Explore your field site:

Set up your notebook: Keep track of what you see and learn in your notebook. Start by giving your location a number and a name. Write this on a new page of your notebook (e.g. Location #1, Strawberry Creek). Below that, write the date and time of your visit.

Step 1: Describe your field site: Spend ~ 5-10 minutes describing your surroundings in your notebook. While sitting quietly, use words and/or sketches to record what you see, feel, hear, and smell. Use as many pages as you need.

Step 2: Take a closer look: Quietly and gently toss your notebook so it lands near you. Now pick up your notebook and observe the area where it landed. Look closely! For the next 10 minutes, use words, numbers, and/or sketches to record what you see.

If you use numbers (e.g. **14** ants, **6** inches long), then you are making **quantitative** observations. If you are describing what something is like (e.g. warm, tiny, bristly), then

Asking scientific questions

Scientists ask a lot of questions, many of which (but not all) lead to investigations. Some questions can't be answered by science and some questions are just too big to answer, so they have to be broken down into smaller questions before scientists can investigate them. So coming up with good scientific questions is an important skill for scientists.

First, a bit of background: A great scientific question is one that you can investigate with materials you have and techniques you are able to do. Here is an example of a scientific question and how you could investigate it:

Scientific question: *Do ants always travel in a straight line?*

Investigation approaches: You could observe ants and place objects in their paths and see what happens. You could carefully pick up some of the ants and head them off in one direction and see what the others behind them do. You could put different chemicals in the pathway (sweet, sour, etc.) and see how the ants behave. This could lead to a study on the movement of ants and some ideas (hypotheses) that you could actually test! For instance, maybe you observe that they usually go in straight lines toward a food source. So you might come up with two possible explanations: (1) they just go toward the food source or (2) they just follow the ant in front of them. Then you could set up an experiment in which you have a large area with food sources in several locations. Place a bunch of ants in the middle and see what they do. If the first idea was correct (they just go toward a food source), then what would you expect to happen? If the second idea was correct, (they just follow the ant in front of them), then what would you expect to happen? If neither of those ideas were correct, what would you expect to happen?

Some questions start too big. When you realize this, you will discover that there are usually smaller questions hidden inside of the original. Here is an example:

- *Why is it so hot today?* That is a hard question to answer! There are many possible reasons that influence a feeling of hotness, like humidity, sun exposure, or ground cover - not to mention how your own body cools off on a hot day! This is a question that needs to be broken down into smaller questions, like is air temperature different over pavement, concrete, grass or dirt? This is a question you could investigate!

Some questions are too simple. An example is:

- *How many legs does a spider have?* That is too easy! Simply counting the legs of a spider you catch, or reading online to answer the question will answer this one! But what if you asked "how do different spiders use their legs for different tasks?" That is a question a scientist might investigate.

Here are some tips for making sure you are asking a scientific question. Ask yourself:

___ Can I investigate it on my own, or is it too big and requires tools and understandings that I don't have?

___ Does investigating the question require more than looking up an answer?

___ Is the investigation safe so there is no danger or risk to myself or someone/something else?

___ Does the question use information that I can collect (or other people have collected) to help answer the question (colors, textures, shapes, sizes, compass points, etc)?

___ Can I (or someone else) repeat the investigation so that more than one set of measurements are collected?

Is your science fair project coming soon?? Use this process to help you find new questions to explore, and to design an investigation that will impress your teachers and classmates with your scientific skills!

Your questions: Now you are ready to examine your 19 questions! Look at them closely. Put a star in front of each question you might be able to investigate. Then pick one question you want to pursue. Just like the ant question, you will probably need to make some more observations or get some more information in order to come up with some ideas that you could test, but that is what science is all about!

Once you have identified the question you are most excited to investigate, grab a friend and go for it! Share your results with friends.

Testing your ideas

Return to the field site and make some more observations about the question that intrigued you. Has anything changed? Do you see any new patterns? Based on what you have already observed, what might explain what you are seeing? Try to come up with more than one idea (hypothesis) – just like we did with the ants. How could you test each idea? Write down your ideas in your notebook and what you would expect to happen if your idea was correct.

For example: In the ant investigation, you might write: If ants just head straight to a food source, then no matter where I place the food, the ants will turn in that direction. But if ants just follow the guy in front, then if I change the direction of the leader, then the ants will follow him. Then you could try it out and see what happens!

OK – all that awaits are your ideas and testing them!!! Figure out exactly what you will need to do and give it a try! If you need to carry out the investigation on another day, that is just fine! Remember to use your notebook to keep track of what you do and what you observe as you are testing your ideas. Once you have completed the investigation, write down what you discovered.

Sharing your discoveries

Now it is time to share your findings with your fellow troop or group members. Gather together your field notes and pictures in a creative way and make arrangements with your troop to share your adventure. Tell them about your field site, what you observed, and the question(s) you explored. What surprised you? What other ways can you expand your investigation? What other questions do you want to explore about your subject? Get their ideas and feedback.

Reflecting on what you learned

You have had quite a scientific journey!!

You practiced observing, learned how to ask and investigate questions, gathered data (observations), posed explanations for what you observed, and then tested your ideas! You have probably learned a lot and you probably have even more questions than when you first started. That is how science works!

With your troop or group, consider what the benefits of the kinds of information you were exploring might be:

What kinds of knowledge or questions emerged from your exploration that might be useful to you? Here are some examples from the ants:

- How could I use what I learned about ant behavior to keep them from getting into my house?
- How can I use what I know to decide where to put my picnic blanket?
- Why are these ants here in the first place? Do they do something important in this field spot? Should we make sure we protect them so they can keep doing their job?

Summarizing your investigation

Ding, Ding, Ding, Ding! Says the pinball machine!

You did it! You began a scientific journey through these activities that will hopefully make you feel more confident in asking questions and more excited about finding the answers for many investigations to come.

Download and print a copy of the flowchart, and map your adventure by drawing lines between your steps.

Was your journey a simple five-step path?? Or were you more like the pinball machine? Where on the flow chart will you go next in continuing your journey?

Now that you are asking questions about the world around you and seeing how exciting it is to test your ideas, you are probably learning how fun it is to have a scientific mindset! Whether or not you become a scientist one day, you can always use the scientific way of thinking to try things in your own life, but, there is a growing movement by scientists to offer opportunities for people like you to help them collect information for their research as well! From astronomy to zoology, there are a wealth of opportunities for you to get involved in science. If you would like to give that a try, move on to the next activity.

Activity 3: Get involved in a citizen science project

There are many scientists who rely on people just like you to help them with their research. We call this type of involvement “citizen science” and you can do it too! Your task is to select a citizen science project of interest and make a contribution to science.

What to do:

Step 1: Grab your science notebook

Step 2: Go to *Sci Starter*, a website that hosts hundreds of citizen science projects.

<http://www.scistarter.com/>

Step 3: With your leaders, register your troop as a user on the site. It is super fast and easy!

Step 4: Explore the different types of projects that exist (the *Project Finder* page allows you to do specific searches), and be sure to find one that matches where you live and that would be easy enough for you to do with your team. Some of the projects you will come across will get you involved in the process of science. Others only teach you about science in fun and creative ways. With this in mind: Find a project that gets you involved in the process.

Step 5: Read the background information and procedures for what you need to do. Before you begin, make sure you have all the materials and time you need to complete your task.

Step 6: Follow the directions provided by the scientists. Ask an adult for help if you aren't sure about any of the instructions. In your science notebook, keep track of your efforts! Have someone take photos of you participating in the different aspects of the project.

Step 7: Share your citizen science efforts! Make arrangements with your troop or group leader to share your experience! Summarize your efforts using the Science Flow chart. Remember that you are helping out on a large investigation, so you may not do all of the things on the flowchart. Science is also about teamwork and others may be doing those parts. Decorate your flow chart with photos and information from your experience. Use arrows to show the different paths that you took and be sure to record any new questions you have.

Activity 4: Share what it means to be a scientific citizen

You are now scientifically savvy; you have conducted your own investigation; and you have supported the scientific research of others! Time to celebrate your new scientific mindset!

Imagine yourself working as a scientist on any of these activities:

We need scientists today to work on critical questions like these:

- how do we create energy that also doesn't hurt our environment?
- how do we improve human health and wellness?
- how do we produce enough food and clean water for our growing population?
- how do we balance the needs of people with the needs of Earth's ecosystems?
- how do we explore the stars, the forests, the oceans and deserts to learn more about them?

As a scientific citizen, think about where you can use science in your life:

- how can I be more efficient in how I use time
- how can I take charge of my health and fitness
- how can I try something new that I have never done before?
- How can I make choices as an individual that reduce how I use natural resources?

Can you imagine yourself investigating challenges that will increase our understandings and help the planet and people for many generations to come? Or can you imagine investigating something that makes your garden grow bigger, reuses rain water to conserve water in your home, or makes a routine task easier?

Now that you are a scientific citizen, share your understanding of science with others!

Take to the internet (with your parent's permission!), your classroom, or your troop or group and share your new understanding of science.

*As a scientific citizen of the world, I observe what's around me and ask questions to improve my understanding. I explore the things that make me go "hmmm..." and share what I learn. I try to be open to new ideas and recognize the importance of evidence.
#scientificcitizen*

