Science Process:
Exploring How We Do Science

4-H SCIENCE BLAST! IN THE CLASS

Key Concept:
When scientists (you) do science, they follow a certain process. It is important that we know the science process and that we use it. In fact, we all use the science process every day, we just don't take the time to stop and think about it.

Grade Level: All grades

Education Subject: Science

Success Indicator:
After completing this lesson, students will:
- Be able to write the steps of the science process.
- Understand the "shape" of science.
- See that science is something they do every day.
- Realize science is relevant to their lives.
- Begin to use this process in their science explorations.

Materials and Methods

Preparation Time: 15 minutes
Lesson Time: 20 to 30 minutes
Space: Classroom
Materials:
- Science Process Signs (available online at *http://4h.msue.msu.edu/4h/science_blast*) Print one for each step of the science process on an 8 ½- x 11-inch piece of paper
- The Science Process Worksheet (one per learner)

MICHIGAN STATE UNIVERSITY | Extension

Developed by Norm Lownds, Ph.D., Curator, Michigan 4-H Children's Garden

Background Information:

Scientists do their work in a specific way and they follow a certain process. It is important that as we do science, we know the science process and use it.

The science process is important so that other scientists can repeat what one person or group has done.

The science process is something that we do every day — we just don't stop to think about it. Here is an example: you walk into a room, flip the light switch and nothing happens. Without even thinking you start doing science.

1. **Question:** You immediately ask yourself, "Why didn't the light go on?"
2. **Research:** You have already done your research, you know that the light is supposed to go on and you know reasons that it might not turn on – the power is out, the bulb is burned out or a circuit breaker has blown.
3. **Hypothesis:** You immediately make a hypothesis: I think the light did not go on because the bulb is burned out.
4. **Experiment:** Your experiment probably consists of at least two steps: First, you check another room to make sure the light goes on in that room. Second, you decide to change the light bulb — remove the current bulb and replace it with a new one.
5. **Collect data:** Your first data is whether other lights are on in the house. When you remove the light bulb you shake it to see if it rattles. After you replace the light bulb you try the switch again and see if the light works.
6. **Explain data:** Your data shows that other lights in the house work, so your data tells you that the power is still on. When you shake the light bulb and it rattles you know that usually means it is burned out. When the new bulb lights up you know that the old one was burned out. You conclude that your data — old bulb that rattles and new bulb that lights up — support your hypothesis that the light did not go on because the bulb was burned out.

Michigan Grade Level Content Standards:

Grades 1-7: Generate questions based on observations/investigations/research (S.IP.01.12, S.IP. 02.12, S.IP.03.12, S.IP. 04.12, S.IP.05.12, S.IP. 06.11, S.IP.07.11); Plan/design and conduct investigations (S.IP.01.13, S.IP.02.13, S.IP.03.13, S.IP.04.13, S.IP.05.12, S.IP.06.12, S.IP.07.12); Construct charts/graphs from data and observations (S.IP.01.16, S.IP.02.16, S.IP.03.16, S.IP.04.16, S.IP.05.15, S.IP.06.15, S.IP.07.15)

Grades 1-5: Communicate and present findings of observations and investigations (S.IA.01.13, S.IA.02.13, S.IA.03.13, S.IA.04.13, S.IA.05.13)

Grades 1-4: Develop research strategies and skills for information gathering and problem solving (S.IA.01.14, S.IA.02.14, S.IA.03.14, S.IA.04.14)

Grades 2-3: Use evidence when communicating scientific ideas (S.RS.02.15, S.RS.03.15)

Grades 3-4: Compare and contrast sets of data from multiple trials of a science investigation to explain reasons for differences (S.IA.03.15, S.IA.04.15)

Grades 5-7: Draw conclusions from sets of data from multiple trials of a scientific investigation (S.IA.05.14, S.IA.06.14, S.IA.07.14)

Grade 1: Recognize that science investigations are done more than one time (S.RS.01.12)

Grade 2: Recognize that when a science investigation is done the way it was done before, similar results are expected (S.RS.02.13)

Michigan High School Content Expectations:

P1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity — length, volume, weight, time interval, temperature–with the appropriate level of precision).

P1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.

7. **New questions:** You might ask why the bulb burned out — was it old, was there something else wrong? You might also wonder if there are things you could do to make the bulb last longer and that might even lead to new experiments.

Instructions:

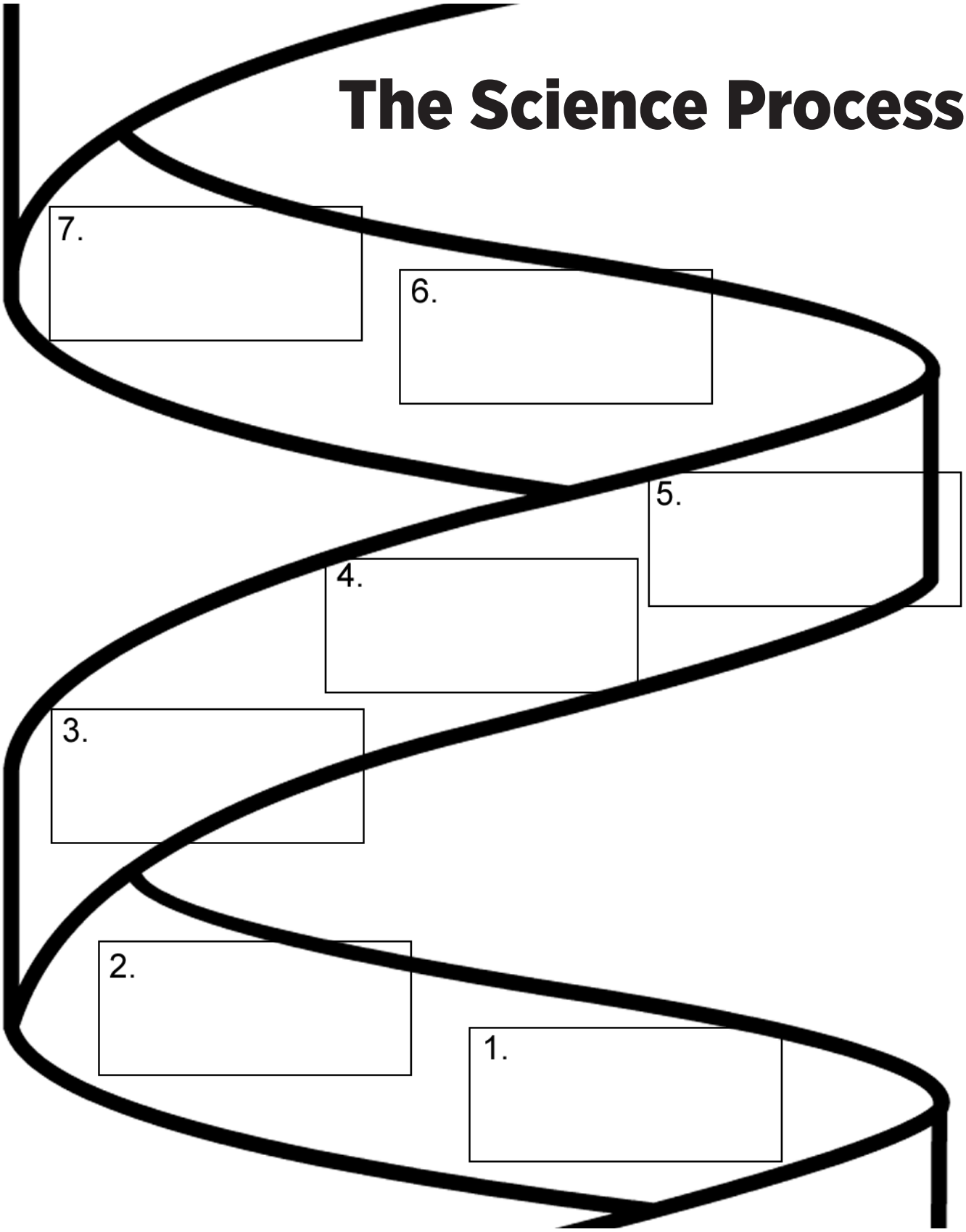
1. Ask for seven volunteers.
2. Give each volunteer a card (8.5 x 11) with one step of the science process written on it.
3. Ask the students to keep the cards turned so others cannot read them.
4. One by one, turn over the cards and read the steps.
5. Arrange the cards into the proper order—ask the rest of the students to suggest the proper order — rearrange your volunteers.
6. Have each student write down each step using the science process worksheet.
7. Have the students look closely at the first and last steps of the process.
8. Now ask, *"What is the shape of science? What does science look like?"*
   Ask the students other questions about science — *"What is its color? What is its flavor? How old is it?"*

Check for Understanding:

- Why is the science process important?
- What is the shape of science?
- What is the color of science?
- What is the flavor of science?
- How do you use science process every day?
- How old do you have to be to do science?

Learn More:

Check out this interactive science process guide at *http://4h.msue.msu.edu/4h/science_blast.*



The Science Process

Doing science follows a process. This helps to insure that we study the topic in a careful, planned and orderly way. It also insures that if someone else tries to repeat the experiment, they will be able to do that accurately. Often this is referred to as the Scientific Method. We find it more useful and practical to talk about science process. The process involves seven steps:

1. **Ask a Question:**
   Science always starts with a question, with something you are curious about, something you want to understand. So ask a question and then you can get started on discovering the answer(s). Scientists are naturally curious, asking lots of questions and then attempting to discover the answers. In some ways science lets you go back to being a little kid where your "job" was to ask questions and discover answers. One of the most important things you can do is to ask lots of questions.

2. **Research:**
   Now that you have a question, you will need to spend some time learning more about your question and things related to it. You have lots of resources to do your research, including: books, the Internet, teachers, classmates, parents, family, yourself and of course the library. As you research you should be able to better define your question and begin to develop possible answers.

3. **Hypothesis:**
   Next you form your hypothesis. This is your educated guess based on all your research. One of the great things about making a hypothesis is that it is not right or wrong it is your best estimate of the answer.

4. **Design Experiment:**
   Here you design and set up the actual hands-on activities that will help you answer your question. Part of designing your experiment is making a list of everything you will need; writing down the specific steps you will need to do and in what order; what data you will take and how often you will measure things; and finally creating the tables, etc. that you will use to record your data.

5. **Collect Data:**
   Once your experiment has started you will collect data. This is usually measurements of some sort that you take daily or weekly or on some regular schedule. Also be sure to write down your observations of what is happening. Often your observations are very valuable as you try to explain your data!

6. **Explain Data:**
   After you have collected your data, you will need to explain it. This is a really exciting part of science because you finally get to figure out what all your hard work means. Often to explain data you will make graphs or tables and use pictures.

7. **Ask New Questions:**
   All through your experiment, things you do, see and measure should suggest new questions that you would like to find the answers to. Write these questions down because they will become the questions that you use for your next experiments! Don't look now, but you are back at the beginning of the process — Ask a Question!

By following this process scientists make sure that they do things the same way each time which means that if you try to do their experiment you will be able to follow their process and you should be able to repeat what they have done.

Now one last science process thing to think about. Look at the first and last steps in the process. Notice a similarity?

Now think about this... what is the shape of science? It does have a shape! Many will say that is is round or a circle — but if you are going in circles you never get any place. Science process, however, results in gaining knowledge and experience. So, take that circle and stretch it out.... into a spiral! Yes, that is the shape of science — a spiral. Where the new questions you ask are based on your old questions plus everything you have learned, so these questions should be more in depth and take you to even more learning!

Actually, if you think about it, this spiral shape is the way we learn everything — building new knowledge and ideas on what we already know.

As you use these "authentic experiments" you will see the science process in each one. We hope that soon you will be thinking about all your science in this way and that this process will become the way that you do all your science.