Lesson Overview
Students view a DVD that uses working scientists to define the meaning of science and explain the processes scientists use to build knowledge about the natural world. Teacher subsequently presents a PowerPoint and accompanying narrative that describes each of the key ideas related to the nature of science (NOS). Students process their ideas; summarizing and illustrating each of the seven NOS concepts on a graphic organizer. Students use the graphic organizer, and Nature of Science Focus Questions to apply their understanding of NOS to their hands-on experiences in science and to their daily lives.

Inquiry
Through listening to scientists talk about their work, as well as historical scenarios presented by their teacher, students explore and make connections with the key ideas related to the nature of science. Subsequently, students use a graphic organizer and synthesize and communicate their understanding by creating both a picture and a “catchy” phrase to illustrate what each component of the nature of science means to them. Students evaluate their thinking by applying their understanding of NOS to analyze scenarios related to NOS. The Nature of Science Focus Questions are used over time to apply and extend students’ understanding and serve as a scaffold to aid them in making connections between the components of the nature of science and their investigations and the greater body of scientific research.

Suggested Time
- Six 20-minute class sessions to create the Graphic Organizer. These sessions should be spread out over a period of a few weeks so students have time to process each concept individually and make connections.
- 10-15 minutes periodically throughout the academic year to use the NOS Focus Questions and Graphic Organizer.

Class Materials
Colored pencils

Preparation
☑ One copy of lesson for each student
☑ Prepare sets of colored pencils for groups of 2 or 4
☑ Obtain the Search for Solutions DVD
☑ Download the Nature of Science Powerpoint – Student Version
☑ Practice the script for Student Powerpoint

Resources
- *Search for Solutions*  
  [http://www.teachingtools.com/EN/Pages/index.aspx](http://www.teachingtools.com/EN/Pages/index.aspx)
- Nature of Science Student PowerPoint  
  [http://mason.gmu.edu/~lpetersn/nos/](http://mason.gmu.edu/~lpetersn/nos/)
- Script to accompany Student NOS Powerpoint

Note: This is a field test lesson created by Linda Peterson, Middle School Science Specialist for Fairfax County Public Schools (FCPS) to assist in the teaching of NOS within the district and across Virginia. Questions and/or comments can be addressed to lkpeterson@fcps.edu.

Additional TEACHER materials (created for the 2010 VA SOL Institutes) can be found at [http://mason.gmu.edu/~lpetersn/nos/](http://mason.gmu.edu/~lpetersn/nos/)

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Key Terms

nature of science

Essential Learnings

► The nature of science refers to the foundational concepts that govern the way scientists develop explanations about the natural world. The nature of science includes the seven key concepts described below.

► The natural world is understandable. The universe is governed by natural factors and forces through which scientists derive meaning by making observations and conducting experiments.

► Science demands evidence. Scientific knowledge is constantly being challenged; therefore, scientists collect data to support the inferences and conclusions they make. Scientists collect both observational and experimental evidence.

► Science is a blend of logic and imagination. Scientists use their sense of wonder to ask good questions. They employ creativity to design investigations and solutions that answer them.

► Scientific knowledge is durable. Scientific knowledge is continually tested. Scientists depend on knowledge collected by previous scientists from which they launch new investigations.

► Scientific knowledge is subject to change. Technological advances often allow scientists to collect data that may refine or correct previously accepted knowledge.

► Scientists attempt to avoid bias. Scientific data are constantly under review by peers who seek to validate the findings. As a result, the scientific community has adopted a strict code of ethics under which they conduct investigations.

► Science is a complex social activity. Scientists interact with many people in order to finance and conduct their work and gain knowledge that allows them to keep current in their field of study.

Teacher Information

Many student texts continue to promote the misconception that there is one accepted way to do science. The so-called “scientific method” explains a process that scientists are thought to use to answer questions and solve science-related problems. In reality, no matter how many solutions are tested, there are limits to what science can do. Rather than focus on a set of defined steps that occur in a rigid pattern, scientists develop their ideas using a blend of several fundamental concepts. We refer to the collection of those concepts as the nature of science. The nature of science forms the foundation for the scientific enterprise as well as for student investigations conducted during the year. By reinforcing and connecting to these concepts, students will, over time, internalize the key ideas related to the nature of science.

Teaching Suggestions

Assessment
Pre-assess students’ knowledge of key ideas related to the nature of science by having them complete the Anticipation column of the Anticipation-Reaction guide. Formatively assess students’ understanding by having them complete the Reaction section of the Guide.
The Nature of Science
Investigating Key Ideas Related to NOS

Grouping
Students should complete the Anticipation-Reaction Guide and note taking steps individually. Subsequently, students may be arranged in groups of 2-4 to process their thinking and exchange ideas. The creation of the picture and “catchy” phrase should be done in groups of 2-4 with each student completing their own graphic organizer. Cooperative groups of 3-4 are advised when students apply their understanding to analyze the scenarios and throughout the year when applying NOS to their hands-on investigations.

5 E Learning Cycle:
Engage
1. Link to students’ prior knowledge by reading together the opening paragraph of the investigation and discussing their ideas related to the questions for investigation.

2. Engage students in the learning task by instructing them to complete the Anticipation column of the Anticipation-Reaction Guide. After completing the Anticipation column, provide some time to allow students to briefly discuss their opinions in a small group so that they are aware of varying positions regarding the concepts.

Explore
3. Show segment One of the Search for Solutions DVD (16 min). Pause periodically to allow students to discuss what they have heard that refers to, supports, or contradicts the position they took on the Anticipation-Reaction guide. Students should record their notes in the column labeled Notes on the Anticipation-Reaction

Guide. Alternatively, students may wish to take notes in the large boxes on pages 3-4 of the investigation.

4. Show the Student version of the NOS Powerpoint from http://mason.gmu.edu/~lpetersn/nos/ and read the accompanying script. The materials on the website were originally developed to build teachers’ background knowledge and were used in the October 2010 VA SOL Institutes held around the State.

However, a student version of the PPT has been designed for use with this lesson. Please resist the temptation to clutter the Powerpoint with additional images. The Powerpoint and narrative have been carefully designed to be visually appealing and uncluttered and to provide some key ideas rather than to be used as a rote teaching tool.

As they listen to the Powerpoint narration, and view the slides, instruct students to take notes in the space provided on pages 3-4 of the investigation.

Break up the showing of the Powerpoint and reading of the script into six 20-minute class sessions. Pacing in this manner will allow students ample time to process and reflect on what they have learned.

Explain
5. After each key idea has been presented, provide time for students to work collaboratively to design a relevant picture and develop a “catchy” phrase.

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An example of a completed graphic organizer complete with pictures and catchy phrases has been provided at http://mason.gmu.edu/~lpetersn/nos/ Consider using it as an exemplar to provide a model of what’s expected. Have groups share with one another and allow individual students to change their ideas if they feel they were off base.

Extend and Evaluate
6. After the Graphic Organizer has been completed, instruct students to return to the Anticipation-Reaction guide and complete the Reaction column. Using their newly-formed understanding of the Nature of Science, they record their opinion about each statement. They should rewrite any statements they continue to feel are false so that they are now true.

7. To apply their understanding of the key ideas of the Nature of Science, arrange students in groups of 2-3 to analyze the science scenarios. Student responses may vary as scenarios may be interpreted to apply to more than one NOS concept. Explain to students that they will be expected to justify their answers and that, as long as the reasoning is relevant, more than one answer is possible.

Have groups compare answers to reach consensus. Consider using a cooperative learning strategy such as “One Stray, Three Stay” to facilitate information sharing among groups.

8. Use the Graphic Organizer and NOS Focus Questions during the year to help students connect their hands-on investigations with the nature of science. Depending on the investigation, assign specific questions from the NOS Focus Questions sheet or ask students to find the questions which are most relevant and provide answers.
Use the Nature of Science Powerpoint – spaced out over time – found at [http://mason.gmu.edu/~lpetersn/nos/](http://mason.gmu.edu/~lpetersn/nos/)

Powerpoint and website have an “exemplar” to help scaffold students’ pictures and catchy phrase development.
Revised 2010 Science Standards
The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which -

Essential Knowledge, Skills, and Processes
Connections are made between the components of the nature of science and their investigations and the greater body of scientific knowledge and research.

Essential Understandings
The nature of science refers to the foundational concepts that govern the way scientists formulate explanations about the natural world. The nature of science includes the following concepts
a) the natural world is understandable;
b) science is based on evidence - both observational and experimental;
c) science is a blend of logic and innovation;
d) scientific ideas are durable yet subject to change as new data are collected;
e) science is a complex social endeavor; and
f) scientists try to remain objective and engage in peer review to help avoid bias.

Science Process Skills
Observing, classifying, inferring, communicating, making models

Unifying Concepts and Processes (NSES)
Evidence, models, and explanation