GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

TEACHER GUIDE

WHAT IS SCIENCE?

GRADES 6-8

COMMON MISCONCEPTIONS

- **All scientists follow one scientific method.**
  All scientists look for patterns in the natural world and, whenever possible, collect and analyze data to identify relevant evidence to explain the causes of those patterns. Scientists in different fields follow different processes to collect data, but the eight science and engineering practices describe the most common activities carried out by scientists across different fields of science.

- **With enough evidence, a theory can become a law.**
  Theories and laws have different purposes. A law is a description of a pattern in nature; it tells you what happens but not why it happens. A theory is an evidence-based explanation of how or why a pattern exists.

- **Scientific knowledge must be developed through experiments.**
  Controlled experiments are a powerful tool that many scientists use to learn about the natural world, but they are not always possible. Scientists have also learned a great deal about the natural world by making careful observations with their own senses or with a wide range of technological tools.

SCIENCE AND PHENOMENA

A Framework for K–12 Science Education summarized research on how scientists and engineers carry out their work. The goal of science is to develop explanations about how and why phenomena happen in the natural world. Scientists in different branches of science ask different questions and take different approaches to answering these questions, but all scientists use evidence to develop claims to answer these questions. Rather than following a single scientific method, scientists engage in a set of practices that they use flexibly to collect, make sense of, and communicate evidence.

THE SCIENCE AND ENGINEERING PRACTICES

The eight science and engineering practices allow scientists to identify questions, develop evidence to support claims to answer those questions, and communicate with other scientists to share and critique those claims. Scientists ask investigable questions about the natural world; they investigate those questions through carefully planned observation or experimentation; they use models to explain, make and test predictions, and communicate their ideas about phenomena; they analyze and interpret data to generate evidence; they use math to analyze data or develop models; they use evidence to support explanations of phenomena; they engage in argument with other scientists to evaluate their claims and evidence; and all these practices require scientists to obtain, evaluate, and communicate information. One interesting finding of research on how scientists conduct their work is that they spend about half of their time on this last practice as they read scientific literature and communicate with colleagues through papers, conference presentations, and other channels.

OTHER DIMENSIONS OF SCIENCE

The practices are one of three dimensions that help define what science is and what students should learn in the science classroom. As scientists engage in the practices, or the “doing” of science, they are also using some common broad themes to organize their thinking and help them make sense of the world. These common thinking patterns that connect different branches of science are known as the crosscutting concepts and constitute the second dimension. The crosscutting concepts are patterns; cause and effect; scale proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change. As scientists construct explanations about natural phenomena, they apply and develop new knowledge that can be organized into disciplinary core ideas, the third dimension. Core ideas in the life, physical, and Earth and space sciences allow scientists in these fields to explain a wide range of phenomena. For example, the ideas about force and motion that students develop to explain the falling Slinky can be applied to understand the motion of any object moving in one dimension.

TEACHER TIPS

The focus of this lesson is on engaging students in science practices rather than building full understanding of core ideas. Although students will need to apply science ideas related to force and motion, be sure to keep the focus on conceptual ideas rather than specific details or vocabulary. Students can describe forces simply as pushes and pulls, and it is not necessary in this lesson to discuss or identify specific laws of motion. The science ideas in this lesson provide a context for engaging in the practices. Because the focus is on the practices, you should review the overview and grade-band expectations for each practice. You can find these on the grade-band matrixes linked on NSTA’s Science and Engineering Practices webpage. Click on a practice to access the grade-band matrix and description of that practice, or click “Download” to access a document containing the matrixes for all eight practices.

ABOUT THIS LESSON

This lesson was created by the National Science Teaching Association (NSTA) to pair with the Generation Genius video and support *NGSS*.

They have requested we provide the following background with this lesson:

The Next Generation Science Standards (NGSS) are the national standards on how students learn science, and they are based on contemporary research presented in *A Framework for K–12 Science Education (the Framework).* The shift in science teaching and learning required by the Framework is summarized in this infographic: A New Vision for Science Education.

At the start of each Generation Genius lesson, students are presented with a phenomenon, then they try to explain it. Students will notice they have gaps in their knowledge and ask questions, which motivates them to build ownership of science ideas they need in order to explain how or why the phenomenon occurred. The way students build ownership of science and engineering ideas is through active engagement in the science and engineering practices (SEPs). This process of sensemaking, or doing science to figure out how the world works, is one of the major shifts the *Framework* encourages.

To engage in the SEPs, students should be part of a learning community that allows them to share their ideas, evaluate competing ideas, give and receive critiques, and reach consensus. Students can start by sharing ideas with a partner, then with a small group, and finally, with the whole class. This strategy creates opportunities for all students to be heard, build confidence, and have something to contribute to whole-class discussions. Each Generation Genius lesson provides conversational supports to facilitate such productive student discussions to contribute to sensemaking.

Excited to continue your shift toward the new vision for science education? Check out the Generation Genius Teacher Guide page on the NSTA website for resources and strategies to engage every student in your classroom in **doing** science.