ACTIVE STUDENT LEARNING

In *active learning*, students fully engage with the material through participation in class work and collaboration with one another. Rather than simply listen and memorize, students "demonstrate a process, analyze an argument, or apply a concept to a real-world situation" (Stanford Teaching Commons, n.d.). Unlike a traditional lecture classroom, SEPUP materials put students' experience at the center of learning by fostering their curiosity and wonderment about the natural and the man-made world.

SEPUP's active student learning supports the scientific practice of *asking questions and defining problems*. *Issues and Science* actively provides opportunities for students to ask and investigate questions about the phenomena and the unit issue, whether they are posting broad questions about the anchoring phenomena to a Driving Questions Board, asking specific questions related to a concept in an investigation, or working to define a problem with other students in a small group.

For example, the *Evolution* unit opens with an engaging hands-on activity: Students use a number cube and chips to model the process of harmful bacteria in the body reacting to an antibiotic in their environment. This prompts students to wonder about what happens when people fail to take the complete course of antibiotics to fight an infection, and introduces the important issue of antibiotic resistance in medicine. Students then generate ideas related to the driving question, *What happens when a person does not take antibiotics as prescribed?* By providing plausible and realistic storylines throughout the units, students have multiple opportunities to explore the relationship between a relevant issue and its related scientific phenomena.

SCIENCE FOR ALL

SEPUP is committed to providing high-quality science learning for all students. SEPUP units:

- Motivate students with relevant and engaging issue-oriented science so students can make a personal connection to what they are learning
- Give students opportunities to ask and investigate scientific questions
- Give students opportunities to design solutions to problems
- Emphasize kinesthetic experiences with hands-on materials
- Embed instructional supports within each unit

- Give students opportunities to use multiple learning modalities
- Represent a diverse population of scientists and engineers
- Make frequent connections to everyday, real-life examples

SEPUP aims to engage students in activities that offer both guidance and flexibility, so that students of varying educational, language, and cultural backgrounds can all access science learning. SEPUP has tested *Issues and Science* units extensively with students in a wide range of classroom settings across the United States to ensure that the materials are accessible and relevant to all learners. This process of field-testing materials and examining student work significantly contributed to making the materials as inclusive and equitable as possible for middle school students.

In every activity, student materials are designed to capture the interest of a diverse student population throughout the lesson. Activities typically begin by eliciting students' prior knowledge and engaging them in the societal issue related to the anchoring phenomena. Next, students work together to complete an investigation, supported by the equipment kit, optional Student Sheets, Visual Aids, graphic organizers, and/or opportunities to share their findings orally. Some activities conclude by having students relate the broader societal issue to a local issue that connects to their lived experiences.

The opportunity to experience science through hands-on activities is an essential part of making science and engineering accessible for all students. The *Issues and Science* equipment kit provides the materials and specialty items students need for the experiences that are central to the instruction. Student equipment provides hands-on, interactive activities for students to safely engage in science practices as they investigate phenomena in cooperative learning groups. See **Quick Start to *Issues and Science*** in the Teacher Edition for more information on the equipment kit.

For more information on how SEPUP supports teachers in engaging three specific populations—students with learning disabilities, English learners, and academically gifted students—see **Comprehensive Teacher Support**.

ENGAGING IN THE PRACTICES OF SCIENTISTS AND ENGINEERS

Attention to the NGSS SEPs in the program design means that students regularly encounter opportunities in *Issues and Science* to engage in these practices throughout their evidence-driven investigations. This might take the form of developing and using a model that explains the geoprocess of erosion and deposition in a stream, analyzing and interpreting data about natural resource

consumption, or designing a solution for an amputee in need of a prosthetic hand that can grab and move objects. These opportunities encourage students to use SEPs to think critically about real-world situations and design solutions to real-world problems.

Wherever possible, students explore a concept by gathering data firsthand or through direct experience. Students frequently manipulate scientific tools to investigate a specific problem or design a solution. For example, they might gather data from an experiment that tests the solubility and malleability of various elements, or use a microscope to make observations about a sample of nematodes. Some lab activities encourage students to plan and conduct their own investigation; in one such activity, students investigate the relationship between the charge on a rod and the force on an electroscope needle. By conducting sound and valid investigations, students become scientists in their own right, using their data as evidence to construct explanations about the natural world.

SCIENCE NOTEBOOK

SEPUP strives to create a classroom learning environment that models the authentic ways in which scientists and engineers work, both individually and in collaboration. To support this work, science notebooks become a critical tool for students and teachers throughout SEPUP activities. A science notebook is a critical tool for students' learning, questioning, and sensemaking throughout the unit, allowing students to authentically engage in the practices of science. Science notebooks encourage reflection and facilitate discourse. In their notebooks, students bring together their three-dimensional ideas as they make sense of the unit issue and phenomena. Students use their notebooks to collect and analyze data, model ideas, develop prototypes, record any questions that arise during investigations and discussions, and build the writing and literacy skills needed in science communication. For more on how to support science notebook use in *Issues and Science*, see **Comprehensive Teacher Support**.

4–2–1 COLLABORATIVE LEARNING MODEL

SEPUP strives to create a classroom learning environment that models the ways in which scientists and engineers work, both individually and in collaboration. Taking part in a learning group allows students to engage in meaningful sensemaking together, as they construct and revise common explanations and reflect on what they've learned about DCIs, CCCs, and SEPs throughout their investigations. The SEPUP 4–2–1 model provides a consistent approach to individual and cooperative learning, and promotes the collaborative construction of knowledge.

In the 4–2–1 model, students work in three different configurations:

4 A group of four shares the physical materials and tools used in most laboratories and investigations; the group gathers data and uses it to draw conclusions from their work together.

2 Activities often call for groups of four to split into pairs for more focused discussion, such as data observation and analysis, or brainstorming solutions to problems. Pairs may then present and discuss their data and observations with other pairs. On occasion, students work in pairs during a Procedure or when responding to specific Analysis items.

1 Students each use a science notebook to record their data and observations and to write their own responses to selected Analysis items. This ensures that each student is individually accountable for mastering the concepts discussed in class.

The 4–2–1 model provides a built-in mechanism for teachers to adjust groupings based on students' needs. For example, if students need more support, an activity designed for completion in pairs or alone can instead be completed in groups of four.

Additional resources for facilitating small-group interaction can be found in **Comprehensive Teacher Support**.

PROBLEM SOLVING AND ENGINEERING DESIGN

SEPUP engages students in the process of engineering design in two notable ways. First, several *Issues and Science* units integrate engineering approaches in each scientific discipline—Earth and space science, life science, and physical science—covered in the program, and students have a number of opportunities to use engineering practices. For example, in the *Energy* unit, students study conduction, convection, and radiation and then apply what they've learned to design a solar oven that can heat water. This activity integrates the SEP of *constructing explanations* about the process of heat transfer with the practice of engineering design solutions by designing a device.

Second, two *Issues and Science* units—*Biomedical Engineering* and *Fields and Interactions*—are fully oriented to the process of design and design challenges. In these units, students are presented with a problem scenario involving a topic relevant to society, for which they must design a solution. In *Biomedical Engineering*, students engage in challenges related to the issue of adaptive science to innovate technology for those with a medical condition or a physical disability. In *Fields and Interactions*, students are immersed in a fictitious scenario where they are challenged to design a transportation system to move cargo and astronauts on the surface of the moon.

SEPUP's engineering challenges provide a comfortable solution space for students. Most design activities provide guidance so that the challenge is not completely open-ended, as middle schoolers generally engage best with more concrete and constrained challenges. In this way, *Issues and Science* challenges are within the realm of what students can reasonably be expected to design, with ample room for creative solutions.

For information on how SEPUP supports teachers in conducting engineering challenges in the classroom, see **Integrating Engineering Design** in **Comprehensive Teacher Support**.

REFERENCES

Stanford Teaching Commons. (n.d.). *Promoting Active Learning*. Stanford, CA: Center for Teaching and Learning, Stanford University.