

## Issue-Oriented Science at the Core of SEPUP Curriculum

Issue-oriented science forms the foundation of SEPUP's curriculum materials. Each unit places science concepts within the context of personal and societal questions. As students explore these questions, they are motivated to learn the science associated with the issue at hand. The science provides evidence that can form and support their decisions. In this way, SEPUP students investigate issues such as water quality, sustainability, and the introduction of non-native species into local ecosystems.

SEPUP's selection of issues is determined by specific criteria to help ensure that the issues in SEPUP materials will be successful in classrooms across the country for as long as they are in print. (See *box to the right*.) These criteria may also help you identify those issues that will be most effective for enhancing your own curriculum. As the role of science and technology in our daily life expands, new issues continue to emerge.

SEPUP implements several different approaches to issue-oriented science. In some cases, a sequence of activities is built around a single issue. For example, the issue of drinking water quality drives the first seven activities in *Issues, Evidence and You*, SEPUP's middle-school-level physical science course. *Science and Sustainability*, SEPUP's integrated science course for high school, weaves issues relating to sustainability throughout all its units, asking students to consider questions such as the role of

*Continued on page 7*

Each issue of the **SEPUP News** now focuses on a topic particularly relevant to SEPUP teachers. Together they form a concise, up-to-date archive of the SEPUP approach to science education.

Past issues and their topics are:

Fall 2003	Assessment
Spring 2004	Inquiry
Fall 2004	Classroom Learning Environment

Please let us know if you're missing an issue and we'll be happy to send it to you.

E-mail us at [sepup@berkeley.edu](mailto:sepup@berkeley.edu).

### Evaluating Issues: A SEPUP Checklist

- Does the issue require knowledge of important scientific concepts and processes?
- Are the scientific concepts and processes appropriate to the grade level and subject matter?
- Does the issue require an application of relevant scientific evidence?
- Is the issue engaging for diverse groups of students?
- Is the issue complex enough to foster discussion and debate?  
(Is there more than one solution or response?)

### Media Literacy: Developing Healthy Skepticism

*By Donna Markey, Vista Academy, Vista, California*

**Issue-oriented science often requires that students do research on their own to gather more information about questions being investigated in class. For example, *Science and Sustainability* students may need to find out more about the role of cloning in food production, while *Science and Life Issues* students may want to learn more about the modes of infectious disease transmission.**

Students today have access to more sources of information than ever before. Some of them are reliable and objective, but many are not. As we teach students to make decisions based on evidence, we need to teach them how to *evaluate* the evidence as well. How can they develop a healthy skepticism of what they read?

Research sources include the internet, as well as television, radio, magazines and newspapers. Regardless of the source, students must learn to use logic and critical thinking skills to distinguish opinions and bias from data and information which can be used as evidence. One way to do this is to answer the five W's:

#### Who?

Who wrote the article? Is the author an authority on the subject? Does the site or article provide a way to contact the author? If the author or institution is not identified, it may be suspect.

#### What?

What is contained on the site or in the article? Are sources documented or annotated? Can the information be verified from other sources? A site heavy in advertisement may be suspect.

#### Where?

Where does the site or article originate? This is often easier to find in print

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## Director's Corner: Using Issues to Teach Science



Issues provide an opportunity to motivate and interest a broad range of students who think they don't like or care about science. When I describe my work to non-scientists, whether good friends or casual acquaintances, the most frequent response is a variation of the following: "I wish I had taken more science. If only my science class had included real-world connections and issues, I might not have avoided it. I think I would have liked it if I saw that it helped people."

In the spirit of science education for all students, it makes sense for all curricula to incorporate issues and other real-world connections. However, in the current climate of concerns in the United States about students' science learning, teachers and educational leaders are often concerned about spending time on other ideas that seem peripheral to science. This is a dilemma that we also face at SEPUP as we make instructional design choices.

As outlined in the lead article of this edition of the *SEPUP News*, the best way to resolve this dilemma is to select the issues for a particular grade level or curriculum as carefully as you select the science content. When the issue requires an understanding of scientific concepts and approaches, it provides another opportunity to explore and reinforce concepts and the nature of science. This can give students a sense of the interdisciplinary nature of problem solving in the "real world" and of the relationships among science, mathematics, technology, and society.

As part of our field testing, we try to identify those issues that appeal to a broad group of students. As a teacher, one of the most important things you can do to enhance science learning through understanding of issues is to bring in related examples from the news and an understanding of your students' lives. By making the issues local and personal, you are more likely to encourage students' interest and involvement.

*Dr. Barbara Nagle, Director*

### Selected Bibliography on Issue-Oriented Science

Aikenhead, G. (2002) The Educo-Politics of Curriculum Development. *Canadian Journal of Science, Math and Technology Education*.

This paper describes some of the education politics related to developing issue-oriented curriculum such as SEPUP materials. It suggests that more influence should come from "societal experts," who are knowledgeable about the public's interaction with science- and technology-related problems, rather than academic scientists.

Ertel, L. (2002, Winter). Out of the classroom and into the real world. *The Link*, 1-2. The article describes the positive experiences which SEPUP materials provide for both teachers and students.

Siegel, M.A. (1999). Changes in student decisions with "Convince Me": Using evidence and making tradeoffs. In *Proceedings of the Twenty First Annual Conference of the Cognitive Science Society*, 671-676.

This study describes the decision-making process of *Science and Sustainability* high school students who analyzed scientific evidence about issues of technology and society using a computer program called "Convince Me."

Snell, V., Baumgartner, L., & Seaver, D. (2000). Design & Decision Making. *The Science Teacher*. 67(6): 29-31.

This article describes how SEPUP uses current issues and guided inquiry in *Science and Sustainability* to motivate and help students learn to design their own experiments and become proficient in making evidence-based decisions.

### How to contact SEPUP

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### SEPUP Materials

SEPUP instructional materials include student books or pages, teacher's guides, and kits. The following are currently available:

**Science and Sustainability:** high school

**Issues, Evidence and You:** middle school  
(available both as year-long course and megamodules)

**Science and Life Issues:** middle school  
(available both as year-long course and megamodules)

**12 SEPUP Modules:** secondary school  
(kit includes CD-ROM and transparencies)

**CHEM-2:** Grades 4-6  
(Spanish student pages also available)

In field test, commercially available late 2005:  
**Issues and Earth Science:** middle school

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solely by Lab-Aids<sup>®</sup>, Inc. (800) 381-8003  
www.sepup.com

# SEPUP Issues in the News: Incorporating the Latest Information into Your Classroom

For those of you who use SEPUP materials, keeping an eye on the news can reap great rewards. SEPUP works hard to select issues that will continue to be relevant as long as the materials are in print. But the work of scientists, policy-makers, and citizens continues. New findings related to a particular issue can generate more interest in an issue or provide new evidence for consideration.

Listed below are some recent happenings related to issues in SEPUP materials. If you're aware of some interesting news we should include, please email us at [sepup@berkeley.edu](mailto:sepup@berkeley.edu) and write "SEPUP Issues in the News" in the subject line. Be sure to include your full name, and the city, and state in which you live, and we'll include it along with the news item.

## Reducing Mercury Emissions in Coal Plants

A new method for reducing mercury emissions from coal plants was proposed in January 2005 as a way to help Indiana improve its air and water quality. In the United States, Indiana released the second highest number of warnings for fish containing high levels of mercury. When contaminated, fish contain a form of mercury known as methylmercury that is toxic to people and can cause neurological damage over time.

The new process involves injecting powdered carbon into the flue gas so that the mercury will stick to the carbon and can then be captured by a fabric filter. Proponents claim that this will reduce the toxic emissions by 90% and could be funded by a \$1.90 increase in monthly residential utility rates. Lawmakers are discussing whether a state can have stricter emissions regulations than those enacted by the United States Environmental Protection Agency.

The issues of environmental release and bioaccumulation of toxic substances are explored in the SEPUP module **Investigating Environmental Health Risks**.

## Harnessing the Energy of Ocean Waves

Cities on both coasts of the United States are exploring ways to take advantage of the abundant energy in tidal currents and ocean waves. In May 2005, New York City plans to install up to six turbines under the East River to provide electricity to a food market on Roosevelt Island. The impact on marine life and the effect of river debris are currently being evaluated.

San Francisco, California is considering an alternative system, already in use in Scotland, in which a large cylindrical device divided into sections by hinged joints is buffeted by waves. This movement would pump high-pressure oil through hydraulic motors, producing electricity.

It is estimated that the amount of available energy from coastal waves in the U.S. is 9 to 10 times more than that currently being generated by its hydroelectric dams, which produce 7% of its energy.

The trade-offs of different sources of electrical energy are investigated in the "Energy" unit of **Issues, Evidence, and You** and the "Moving the World" unit of **Science and Sustainability**.

## Fueling Cars with Sugar-Based Fuels

Growers of sugar cane in the United States are seriously considering producing ethanol from molasses as a way to counteract the rising cost of crude oil and the current decrease in income from sugar products. A fuel made up of gasoline and 10% ethanol would cost 5% less than regular gasoline. Many other countries have begun making ethanol from molasses. Ethanol is already being produced from corn, and it has been proposed to produce it from molasses during the fall and winter sugar cane grinding season and during the summer from corn in order to provide a year-round supply.

Today, most cars in the U.S. are fueled by gasoline or diesel, both derivatives of crude oil. Currently, commercially-available alternative automobile technologies include: battery-powered electricity; biodiesel such as recycled vegetable oils; alcohols such as methanol; and fuel cells such as those powered by hydrogen.

The use of biofuels such as ethanol is explored in the "Moving the World" unit of **Science and Sustainability**.

## 90% Drop in North Atlantic Predatory Fish Populations

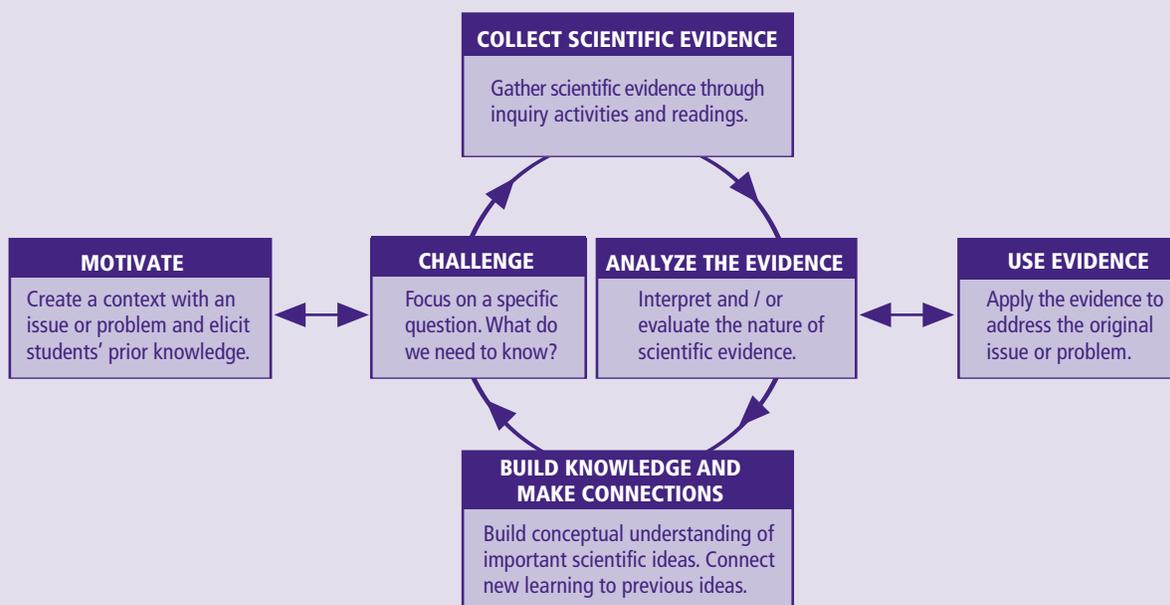
In a 2005 study, the Pew Institute for Ocean Science and Census of Marine Life found that the populations of some predatory fish in the north Atlantic were depleted by over 90% in the past 40–50 years due to the impact of industrial fisheries. Several strategies have been proposed to slow down or stop this trend, including reducing bycatch mortality wherever possible, implementing some seasonal or permanent closures, further restricting fish limits, and establishing some permanently closed marine ecosystems.

The Pew Institute has recently put forward a new approach to fisheries management: ecosystem-based fisheries management, which focuses on factors such as habitat health, predator populations, and the prey of target species all at one time. Historically, fish stocks have been managed one species at a time, with both problems and solutions considered fish by fish.

The interaction of organisms within an ecosystem is investigated in the "Ecology" unit of **Science and Life Issues**.

## The Role of Issues in the SEPUP Instructional Model

SEPUP curriculum materials are based on the instructional model shown below. This model has been strongly influenced by the learning cycle developed by the late Dr. Robert Karplus, professor of physics at UC Berkeley, and SEPUP founder Dr. Herbert D. Thier. Personal and societal issues can be incorporated into all aspects of this model. Most often, issues provide a context for introducing important science content (MOTIVATE). They are also used to assess students' ability to apply evidence (USE EVIDENCE).



To motivate students, a personal or societal issue provides a framework for each SEPUP unit, and students' questions about the issue reveal their prior knowledge and understanding.

Each activity begins with a challenge—a specific question or goal. First, students collect evidence in guided or open-ended investigations. Readings provide background. Next, students analyze their evidence and use it to build scientific knowledge to address the issue.

Students use their evidence to reach a decision or to solve the original problem, which gives them an opportunity to apply the relevant scientific concepts and principles.

The activity on the next page is from the *Living with Plastics* module. The module uses the instructional model above as a framework for its investigations. Students begin by considering the trade-offs of using different materials, such as aluminum, glass, and plastic, to manufacture a product. Through a series of investigations and readings, they explore the properties and uses of plastic. They learn that plastic is not a single material, but it refers to many different polymers, each with different properties. In the culminating activity, students are asked to separate the facts from fiction relating to plastics before re-visiting the initial question: What is the best material to make a product?

## Plastic Fact or Fiction?

### ••••► CHALLENGE

#### Can you identify the truth about plastic?

The use of plastic continues to increase, and more of the waste stream is made up of plastic. In 1960, Americans threw away 390,000 tons of plastic. That number was up to 24,170,000 tons by 1999. In the United States, the most common way of handling waste is placing it in landfills. One concern, however, is that today there are 70% fewer landfills than there were just 15 years ago.

### ••••► PROCEDURE

Read the claims below about plastics from two different organizations.

### ••••► ANALYSIS

#### Individual

4. What information about plastics is missing or misrepresented:
  - a. In the ad from Plastics Plus, Inc.?
  - b. In the flier from NMPP?

#### Ad from Plastics Plus, Inc.

### \* PLASTICS \*

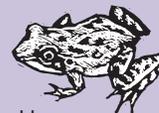
THE FLEXIBLE SOLUTION

Finally, the solution to all of your problems: plastics! Plastics have been around forever, and they will never change. Now modern science can create plastics in any shape. They can be used to make anything. They are flexible, stretchy, and strong. Because they don't break, they are extremely safe. Plastic containers can be made in any color, won't melt, and can hold any chemical. Plus, they are recyclable. This means no waste. Plastics hardly use any energy to produce. You can't make a more environmentally friendly polymer! Why not give plastics a try?

~ Plastics Plus, Inc.

#### Flier from NMPP

### No More Plastics, Please!



Plastics cause nothing but problems.

Plastics are cross-linked polymers. This means that they can never be broken down. They are only used to make bottles that can't even be recycled. Because plastics are usually cheap, most people use them once and then throw them away. And the fact that plastics float means that they end up polluting the water and endangering wildlife. A lot of different raw materials are needed to make plastic, so using more plastics means ruining the environment.

**So listen to our plea— no more plastics,  
PLEASE!**

# Role of Evidence and Trade-offs in Issue-Oriented Science

At the core of SEPUP's issue-oriented approach to science education is the concept of "evidence and trade-offs." Most of the issues presented are complex and require careful consideration of opposing viewpoints. Students learn to separate evidence from emotion and weigh the evidence for and against various options. As part of their analysis, they are asked to evaluate the trade-offs of their decisions. These skills are essential for developing scientific literacy and making informed decisions about both personal and societal problems.

Students use evidence gathered from their hands-on investigations, readings, discussion of others' viewpoints, research, and life experiences in their decision-making process and learn to distinguish evidence or observation from inference and opinion. At the high school level, they are also expected to consider the source and quality of evidence.

Once students have gathered evidence about their options, they then weigh the evidence to see which option best meets the goals of the decision. For example, if a decision has three possible options, students may find that the evidence rules out one of the options, but the other two are each supported by some of the evidence. The students must weigh the evidence available and the goals of the decision to distinguish between the remaining two options.

As they do this, students realize that there is no perfect solution and their choice must involve trade-offs—the positive outcomes given up (or negative outcomes accepted) in order to achieve other positive outcomes. When they make their decision, students must be able to explain their reasoning and the trade-offs they have made.

The importance of these skills are reflected in the SEPUP assessment system. In addition to assessments of content and inquiry, the system includes assessments of students' abilities to apply their understanding of science and the approaches used by scientists to societal problems and issues. The "Evidence and Trade-offs" variable and its associated scoring rubric assesses students' ability to evaluate evidence and trade-offs when they are asked to choose one of several possible solutions to a problem.

The song on the right was written by Andy Coblentz for his 6th grade students who are field testing **Issues and Earth Science** in Daly City, California. He used it to highlight the trade-offs in the "Shaping the Land" unit.

## Some Examples of Evidence and Trade-offs Questions

- ? Some people want to ban the use of MTBE. Other people want to keep using MTBE to reduce air pollution. Do you think MTBE should be banned? Support your answer with evidence and identify the trade-offs of your decision. (**Environmental Health Risks** module)
- ? Do you think Waterville should build new houses on the marshland, hillside, or cliff? Describe how you weighed the advantages and disadvantages of each location. (**Issues and Earth Science**)
- ? Do you think that vaccinations against the flu should be required? Explain. Support your answer with evidence and identify the trade-offs of your decision. (**Science and Life Issues**)

## Winter Conference: Earth Science Field Test



In January, 25 field test teachers from 8 centers joined the SEPUP staff at the Lawrence Hall of Science in Berkeley to prepare for the last semester of the Issues and Earth Science field test. This course, SEPUP's new year-long middle school earth science course, will have been field tested for two years and will be commercially available late 2005.

## Where We Gonna Build?

*Chorus:*  
Movin' from the east, movin' from the south  
Comin' on down to Waterville,  
Hillsides, the cliffs, maybe the wetlands,  
Where we gonna build?  
  
The cliffs overlook the sea—  
A picture of harmony.  
You'll have great views.  
When big waves come,  
You'll have quite a bit to lose.  
(Chorus)  
  
The hill's view puts you at ease,  
But you'll be takin' out trees,

*Loos'nin' soil and rock.  
When comes the November rain  
The house might not remain.  
(Chorus)  
  
The wetlands are flat and low,  
Cattails and rushes grow.  
Watch that water flow.  
In a big flood,  
Your house might fill with mud.  
(Chorus)  
  
Where we gonna build?  
Where we gonna build?  
Where we gonna . . . BUILD?*

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## Teaching Tips: Issue-Oriented Science

Issues that are relevant to students' lives can be motivating and enjoyable additions to the science classroom. Most importantly, they can be used to further students' understanding of the role of scientific principles and evidence in making informed personal and societal decisions.

The following tips can enhance your use of issues to teach science content.

-  Introduce the issue and some of the options that might resolve the issue.
-  Elicit students' ideas about the issue and/or the type of evidence that could inform their decision about the issue.
-  Use students' knowledge, understanding, and opinions to generate a list of questions about the issue and related science. Post the list of questions in the classroom. Record responses and new questions during the course of the unit.
-  Whenever possible, connect the issue to current events and local concerns. Local newspapers, guest speakers, and local organizations and businesses may provide additional information about local aspects of the issue.
-  Explore the scientific principles and evidence related to the issue. The relevant science concepts may be more numerous than those investigated in the specific unit being studied.
-  As students investigate the science related to the issue, re-visit the issue regularly to discuss newly gathered evidence and new questions.
-  Provide an opportunity for students to make a decision or recommendation about the issue.
-  Be sure students explain how scientific principles and evidence helped them to understand the options and reach a decision about the issue.
-  Emphasize that science can often provide important information and understandings about an issue. People then use that information to make decisions based on varying concerns, viewpoints, and priorities.

## A Word from Lab-Aids

Mark Koker, Director of Curriculum and Professional Development

### Announcing the 2005 SEPUP Academy

Join science educators from across the country and improve your use of SEPUP materials at the 2005 SEPUP Academy. This three-day conference will be held June 27–29 and includes presentations and workshops by senior staff of SEPUP, Lab-Aids, and some special guests. This year's Academy program will be held at the Loyola University of Chicago campus, located on the north side of Chicago, and on the shores of Lake Michigan. The cost for the Academy is \$1,950, which includes all air travel and ground transfers, lodging and meals, and all conference materials and training. Course credit is available at an extra cost.

Participants may plan their programs to reflect their interests. After completing the required courses in assessment, literacy, inquiry and the use of issues in SEPUP, they can choose electives dealing with technology, taking leadership for SEPUP, writing effective grants, using the program in urban school systems, and more.

Participants in the 2004 program, held in Berkeley, rated the program highly. "The experience was very enjoyable and the camaraderie was palpable," said Amy D'Andrea, a middle school teacher from Lakewood, Washington. "I am attempting National Board Certification this year and am counting on what I learned at the Academy and the SALI curriculum to help me get through the process and keep my sanity intact. The SEPUP academy has added valuable tools to my 'learning' toolbox!"

For more information, visit us on the web at [www.sepup.com](http://www.sepup.com), or call Ayse Frosina at Lab-Aids at 800.381.8003, ext 120. We hope to see you there!

### Issue-Oriented Science *continued from page 1*

bioengineered foods in feeding a growing world population.

Students also have opportunities to discuss specific case studies about issues. In *Science and Life Issues*, SEPUP's middle school life science course, students begin a unit on ecology with a story about the introduction of Nile perch into Lake Victoria in Africa. The complexity of this event lays the foundation for the science content that is covered throughout the unit. In fact, students work independently to research a variety of introduced species and their ecological impacts.

SEPUP has several goals in developing issue-oriented science curriculum. Issue-oriented science provides a real world context for learning science and often motivates student participation. In addition, students are expected to use scientific evidence to make decisions.

SEPUP does not advocate a specific position, but provides students with the knowledge and skills to help them make their own informed decisions. They collect and analyze data, and use their data as evidence to form and support their decisions. Students also learn to identi-

fy and describe the inherent trade-offs when they select one alternative over another. (*See article on opposite page.*) This approach engages students in learning science and helps them understand the everyday relevance of scientific concepts. Please let us know if you find an issue that you think will work well in SEPUP.

### Media Literacy *continued from page 1*

resources than on the internet, although the URL can provide clues. For example, sites for government institutions and non-profits end in "org" or "gov" and educational institutions contain "edu," while commercial sites end in "com."

#### When?

When was the information written? Is it current enough to be of value? Is it updated regularly?

#### Why?

Why did the author write the article or post the site? Is the intent to present information, sell something, persuade or criticize? Knowing the purpose can help determine how objective and useful the information will be.

# SEPUP News

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Spring 2005

## Calendar

### Selected SEPUP Workshops

#### NSTA National Convention, Dallas, TX

Professional Development Institute: "Understanding Student Learning Through Assessment in Science,"  
Lawrence Hall of Science leaders from SEPUP, GEMS, FOSS and other programs  
Wednesday, March 30, 8:00 a.m.–4:30 p.m., Thursday, March 31, 8:00–10:00 a.m. (preregistration required).

#### Thursday, March 31

8:00–9:00 a.m. "E-Waste: Where is 'Away'?" (featuring activities from SEPUP module, *Waste Disposal: Computers and the Environment*), Lynne Hehr, University of Arkansas

#### Friday, April 1

8:00–9:00 a.m. "Assessing Inquiry in Middle School Science," Barbara Nagle, SEPUP Director, and Lee Amosslee, SEPUP Instructional Materials Developer  
Room 223/224 Dallas Convention Center

9:30–10:30 a.m. "Assessing Inquiry in High School Science," Barbara Nagle, SEPUP Director,  
Room 223/224 Dallas Convention Center

The following workshops are sponsored by Lab-Aids<sup>®</sup>, Inc.

#### Saturday, March 12

Connecticut Science Educators Professional Development Day  
"Challenging Issues of Science and Sustainability for High School"  
"See Your Middle School Students Soar with SEPUP"

#### Saturday, March 19

California League of Middle Schools Annual Conference  
"SEPUP Support of Literacy & Numeracy in Your School"  
"Use Embedded Literacy Strategies While Doing Engaging Inquiry Science"

#### Friday, April 15

Wisconsin Society of Science Teachers  
"What Should Inquiry Teaching and Learning Look Like in the Classroom?"

#### Saturday, April 16

Science Council of New York City  
"Environmental Science That All Students Can Use"  
"New Modules From SEPUP"