FOSS Middle School Update: Planetary Science

The first FOSS middle school course to be revised is nearing publication! Planetary Science, Second Edition, will be available in 2012. Revising a FOSS middle school course means working closely with teachers, examining current research in pedagogy, following news updates in the content area (since planetary science is a constantly-evolving field), and lots of field-testing.

We chose to revise the Planetary Science Course for two main reasons. It was the oldest course, first published in 2001, and it had the greatest need for content updates. For example, in 2001, one exoplanet (a planet orbiting a star other than our own) was known to exist. At the time of this newsletter printing, over 500 exoplanets have been confirmed and there is evidence for 1,235 other possibilities! In addition to content updates, we wanted to redesign the course to represent the most current research in the areas of formative assessment and student-centered notebooks. And overall, we wanted to make the course easier for teachers to teach and more beneficial to students’ learning.

The process begins with research. We communicated with teachers using the FOSS Planetary Science Course in the classroom to find out their concerns and needs, as well as getting input from former teachers who are now part of the FOSS staff. We looked at current planetary science news and research to find out what the big questions in the field are today, and we looked at state standards to find out what requirements teachers and districts need to meet.

We examined all these data and brainstormed about what to keep, what to add, and what to cut from the original course. The last question is always the hardest, but very important, since we know that teachers need to be able to get through the course in 9 to 10 weeks. We wanted to make sure we have Continued on page 2
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For more Information

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Middle School Update continued

depth of content to provide a rich learning experience for students, not just breadth of content to cover all the required standards.

Once we had a workable conceptual map for the course, we looked at new investigations that needed to be developed and worked with some local classrooms to test out the hands-on components. After lots of tweaking, we were finally ready to test the new course. Armed with an outline of what we hoped to accomplish, we worked with a local teacher to test the revised course. As those of us who work in classrooms know, the best-laid plans are put to the test when you’re actually facing a group of real students! So we collected data about what worked, questions the students still had, and areas requiring further development.

After looking at all the data, our middle school team got busy writing. Finally, we were ready with a draft of the revised Teacher Guide. We recruited a group of 10 teachers from across the country to travel to the Lawrence Hall of Science for training on the new course. Then, while they taught the course in their classrooms over the next few months, we made numerous site visits, collected quantitative and qualitative feedback from the teachers, and collected assessment data and other student work for analysis.

We compared pre- and posttest scores to measure whether the course addressed the content we intended. We analyzed notebook samples and teacher comments. We prepared statistical analyses of all the test items to check for validity. Using all the data we’d collected and their analyses, we made decisions about the changes we wanted to make, and then began the process of revising the Teacher Guide and student materials for our final published course.

As you can see, a tremendous amount of research, collaboration, and time goes into the development of each FOSS middle school course. The middle school team has worked diligently to prepare the best possible course for our students. We are exceedingly pleased with the outcome, and we are confident that FOSS users will be too. For more details about one aspect of the research done during trials, read the next article to see how Rebecca Deutscher, Ph.D., a FOSS researcher, designed a research study analyzing students’ use of the multimedia.

Summary: How Does Multimedia Integrated within a Planetary Science Course Help Students with Difficult Material?

By Rebecca Deutscher, Ph.D., Research Associate Specialist, Lawrence Hall of Science

In March 2010, I presented a paper at the National Association of Research in Science Teaching (NARST) Conference in Philadelphia, Pennsylvania. NARST is a worldwide organization of professionals committed to the improvement of science teaching and learning through research. The goal of the project was to evaluate the impact of using the FOSS Planetary Science Course, Second Edition, middle school multimedia to teach material that is difficult and not easily observable by other methods on student learning, understanding, interest, and motivation. In addition, I hoped to get feedback on students’ experiences with the multimedia to help in the redesign of the course.

Method

The data were collected from student and teacher feedback, observations, student think-alouds, and pre- and posttest assessment items. I looked at two multimedia components from the course, “Phases of the Moon” and “Jupiter’s Moons.” As part of the think-aloud, students were asked to talk about their experiences and thoughts as they were going through the multimedia. Eight students did think-alouds for “Phases of the Moon,” and eleven students did think-alouds for “Jupiter’s Moons.” Figure 1 displays a screenshot of “Phases of the Moon.” The students had
the opportunity to visually see how the Moon changes over time and during different times of the day.

The “Jupiter’s Moons” multimedia involves two different perspectives of the moons orbiting around Jupiter. Figure 2 displays a screenshot from “Jupiter’s Moons.” The top image shows a side view and the bottom image shows a north-polar view. The students observed how quickly the moons orbit around Jupiter based on each moon’s distance from the planet, and they had control of turning on and off the orbit lines and moon name labels.

Findings

All of the students who participated in the Planetary Science Course were given a pretest and posttest. The tests include two questions related to phases of the Moon and one question related to the moons of Jupiter. The students performed better on the posttest than the pretest for all three questions. Overall, the curriculum helped improve the students’ understanding of the material. Based on the three items on the tests, the multimedia was an integral part in helping students learn more about the Moon’s phases and the moons of Jupiter.

Multimedia Themes

Some common themes developed through analysis of the think-alouds from both multimedia components. The first theme that emerged involved the interactivity of the multimedia. Both of the multimedia components have some interactivity; they both allow users some control over the virtual environment. “Phases of the Moon” includes a game format that consists of some interactive elements. “Jupiter’s Moons” is more passive, but students can turn on and off labels and orbit lines. This gives students some control over the environment. The students we worked with enjoyed the interactive nature of both multimedia components. In developing multimedia, it seems that even adding a small amount of control, like labels, can help students have a more positive experience.

Students suggested having more help features or ways to find out more information. Some of the students felt the “Phases of the Moon” multimedia was confusing and that help features would be useful. In “Jupiter’s Moons,” the students seemed to understand how to use the multimedia, but some students did not understand that the purpose of the multimedia was to compare two perspectives of Jupiter’s moons. In addition, some students wanted to be able to learn more about Jupiter and its moons. Spending time with the help features and examining various ways to improve those features for students has the potential to enhance their experiences.

Students seemed to enjoy trying to figure out what was going on with “Phases of the Moon” and “Jupiter’s Moons.” Neither of the activities is straightforward, and students had to figure out what was going on and how to use the activities. Most students seemed to enjoy this aspect of challenge. Part of the reason video games are so popular is the challenge involved in playing them. Adding challenging features to the multimedia enhances the experience for many students.

Both of the multimedia components involved some type of change in perspective. They involved perspectives that students might not normally notice or perspectives that they cannot take in everyday life. Students often talked about liking the perspective-taking component of the multimedia. This is one way multimedia can be very helpful to students, by allowing them to see things in a different way and expanding their understanding of various concepts.

In developing multimedia, we need to be careful that students do not misinterpret the content that is being presented. Since much of the material may be pictorial in nature, it is important to think about what meaning or information is being conveyed by the images. In the “Jupiter’s Moons” multimedia, about half of the students thought that Jupiter only had four moons, since only four moons are displayed. In the curriculum, a discussion that Jupiter has more than four moons

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Multimedia within a Planetary Science Course continued

is included. However, it is also important that the number of moons is somehow represented in the multimedia. This example reflects how easy it is for students to misinterpret information that is being displayed in a multimedia activity.

The last theme that developed from examining the think-alouds is the importance of student input when developing multimedia. The students had a lot of ideas about changes that could be made to the multimedia. In addition, we were able to identify the features that students did not understand or misconceptions they had about the material, such as the number of moons that orbit Jupiter. This feedback from the students is extremely valuable in improving the multimedia.

**Conclusion**

The results indicated that the students performed better on the posttest than the pretest. Students understood the material better as a result of the combination of the curriculum and the multimedia component. In order to understand more about the students’ multimedia experiences, students were asked about their perspectives. The students described how they had learned about phases of the Moon and Jupiter’s moons in some of their other curriculum material, but the multimedia added a visual component that helped them better understand the phases and better see the continuity in the process. Also, with “Jupiter’s Moons,” students felt they understood better how the moons orbit the planet. For both of the animations, students felt the multimedia helped their understanding of the material.

Many students also felt that the multimedia stirred more interest learning about planetary science. Some students said that they thought that the multimedia was fun and interactive. One student wondered about what happens with other moons and other planets. This excitement about learning and wanting to find out even more information about the topic was observed while these students used the multimedia animations. The students also gave feedback on how to improve the multimedia, which helps the FOSS staff improve the quality and enhance the educational value of multimedia components. In future studies, we can then examine the impact that the further-revised multimedia has on enhancing students’ learning experiences, interest, and science skills.

The full paper may be viewed at:
Ideas from Evansville

Here’s an e-mail we received a few months ago with some ideas for using FOSS materials.

I am a K–4 science specialist. We love FOSS kits. My fourth-grade students use Crayola® Model Magic® to create their own bess beetle for the Structures of Life Module. The beetle then sits on a foam meat tray, and the students label the body structures with a permanent marker.

My second-grade students planted eyes of potatoes for the New Plants Module in plastic cups donated by a local pizza franchise. The cups have two holes punched in the bottom so children won’t drink from them.

For the Earth Materials Module, I got champagne corks from a local wine shop for covering the points of the geologist tools (the nails). They have a bin for recycling corks and were very nice about letting me dig through the bin.

Best regards,

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I t was February, and I was in Myanmar when I received the first e-mail: There may be a professional development session in South Korea. If it develops, are you interested?

It was about two months before I heard any more about Korea. Then a long e-mail from the Delta representative for International Sales, Jennifer Selby, provided some initial thoughts about the training. The Korean Foundation for the Advancement of Science and Creativity (KOFAC, http://www.kofac.or.kr/en/index.jsp) had purchased FOSS modules and was scheduling three days of professional development for teachers. The training would be for different levels on each of the three days (K–2, 3–5, 6–8) and would involve teachers from around the nation. The kits would be available in a classroom setting with approximately 30 teachers each day. It sounded like a pretty standard set-up for a FOSS workshop.

I worked as a FOSS PD consultant for over five years. After I retired, I began traveling to other school districts. One thing I had discovered was, regardless of the situation (rural/urban, wealthy/poor, black/white), most teachers faced very similar problems and challenges in the classroom—particularly finding time to do inquiry science (or do science at all) and getting support from home and administration. In fact, I found many more similarities among classrooms in America than I found differences.

However, my foreign travels had taught me that cultural differences are very real. Here’s one example: I volunteered to do a teacher workshop at a small school in Haiti to introduce the idea of inquiry learning. This was not related to FOSS, so I had taken some hands-on supplies to use, including some polystyrene foam balls. The founder of the school noticed them in my luggage and asked, “What is the purpose of those?” I told him the teachers would use them as models of the Moon to simulate phases. He was thoughtful for a few minutes then remarked, “I have to tell you that, during our training as teachers, neither I nor my staff will have ever encountered anything like that.” I realized that my starting point would need to be much different in their culture than in any school in the United States, since even the basic idea of hands-on science was not part of their worldview.

A friend in Myanmar told me that his culture considers it rude and disrespectful to even ask a teacher a question. Doing so indicates a distrust of the teacher. Of course, the very basis of inquiry learning is questioning. So I knew there would be challenges in presenting FOSS’s inquiry learning model to an Asian culture.

I communicated with the Korean representative of KOFAC, Dr. Min Young Kyoung. She was extremely helpful in giving the information I needed and in making sure everything was set up. During this long-distance planning time, KOFAC requested that we change the venue to the Korean Science Festival. This annual event is the largest experience sponsored by KOFAC. It is similar to a national science fair combined with an NSTA conference. Our main concern was that the teachers in our workshop would be committed to a full day and not be coming in-and-out during the day. After getting assurances that the commitment would be there, we changed the dates to correspond to those of the festival.

We ironed out most of the logistics via e-mail over the next several weeks. I made the journey to Korea. Despite the language issues, the people were as friendly as any I’ve met anywhere in the world. That applies especially to Dr. Min and the others from KOFAC. Later some reporters interviewed me. With the interpretative help of an intern, Jason Jeong, I tried to encapsulate the core of inquiry learning. I don’t know if any of my thoughts were ever published, but I felt good about the information we had disseminated.

On Wednesday, we began the Creative and Active Learning Science Seminar, as our workshop had been dubbed. When I arrived, everything was as Dr. Min had said it would be: a large classroom setting with tables, laptop with projector and Internet, certain FOSS modules, and handouts. The room was set up with eight groups of tables, each of which could seat up to eight. Dr. Min had planned on six groups of six teachers each for the seminar. She had also hired a young man, Hoon Lee, to act as a translator/interpreter.
This first day was intended for K–2 teachers so I used the **FOSS Balance and Motion Module** as the way to demonstrate the FOSS approach to inquiry. We spent most of the morning doing Investigation 1, *Balance*. As we did the lessons, I pointed out the various components of the program, such as materials lists, response sheets, lesson plans, equipment, etc. After seeing how the lessons were structured and why, we used a PowerPoint presentation and FOSSweb to show how the curriculum works and the tools and support available to teachers.

For the afternoon I intended to assign teams certain investigations from various FOSS modules and allow them to plan and present their own lessons. This is where we encountered various “challenges.” First and foremost was the language barrier. While most Koreans have some knowledge of English (certainly much greater than my knowledge of Korean), they seem to be less proficient than I have encountered in other parts of Asia. That became evident when they tried to read and translate the FOSS lessons on their own. Things went very smoothly that morning. As we did Investigation 3, I decided to provide more guidance with the afternoon activities than the previous day. However, I had not anticipated the new challenges. Hole-puncher malfunction, lack of a stapler, and failure to follow directions (endemic among teachers of all nations!)—all presented challenges. Nonetheless, it was very successful overall, and I felt good about the effectiveness of the day.

The final day was for middle school teachers, and I knew it is always a challenge to present the FOSS middle school program in one day since it is so comprehensive and challenging for students. I used the **FOSS Force and Motion Course**, intending to do Investigation 1, *Here to There* (using air trolleys to introduce concepts of motion) and Investigation 6, *Force*, to introduce forces. Aside from the ubiquitous challenges of following directions (exacerbated by language difficulties), Investigation 1 went well. The same can be said for constructing and using the “pushers” in Investigation 6. However, I had failed to take into account that I had no four-foot long boards to do the rest of the activities on motion. So, we elevated some tables on one end and proceeded.

Even with all of the challenges, I consider the seminar quite a successful venture. Dr. Min and the others from KOFAC were complimentary and seemed satisfied with the results. I learned some things, and I believe the participants went away with a better understanding of inquiry learning and of the FOSS program.
How can a summer-learning experience for elementary students be structured to minimize summer-learning loss and maximize student achievement across contents? In 2010, the Boulder Valley School District in Colorado offered a six-week Summer Science Camp for approximately 1,000 students, all of whom were either English-language learners and/or students with disabilities. Hands-on, inquiry-based FOSS modules and science-notebook strategies served as the core instructional framework for extending the learning opportunities beyond the traditional school year, providing enrichment in science and empowering students as learners.

Boulder Valley School District (BVSD) in Colorado has 29,349 students in grades K–12 and spans an area of over 500 square miles. English-language learners are 8.5% of our student population, and 9.3% of our students have individualized educational plans (IEPs). Students receiving meal assistance are 18.4% of our student population.

BVSD has a large and persistent achievement gap between students overall and students in a variety of sub-groups (Latinos, English-language learners, students receiving meal assistance, and students receiving special education services, see Figure 1). Our district is not unique in this phenomenon. At the national level, the gap between average performance on the fourth-grade science portion of the National Assessment of Educational Progress (NAEP) shows the gap between students eligible for meal assistance versus students who are not eligible to be relatively stable from 1996 to 2005, while the gap between Hispanic and white students has narrowed only slightly (National Center for Education Statistics, 2005).

While the factors contributing to this pattern are complex and intertwined with larger societal issues of oppression based on race and class, there is one factor with significant empirical support to suggest a role in contributing to the achievement gap. That factor
is summer-learning loss—the decline in students’ knowledge or skills over summer break, as measured by standardized assessments administered in the spring of one school year and the fall of the next school year. Numerous studies indicate that summer-learning loss is greater for students from low-income families than for students from middle- and upper-income families (Cooper et al., 1996).

That English-language learners would be especially vulnerable to summer-learning loss due to limited opportunity to practice reading, writing, speaking, and listening in English is a reasonable hypothesis, but there is little research evidence to support it at this point. Nevertheless, the development of oral and written English-language skills is critical to students’ ability to access content in science, as well as social studies and mathematics (Echevarria, Vogt, & Short, 2004). Of particular importance is the development of academic styles of language that differ from everyday conversational dialects (Gee, 2008). Practice in the use of academic language in the context of learning science should result in both faster acquisition of academic English-language skills and development of proficiency in the domain of science.

The BVSD model for Summer Science Camp was designed explicitly to improve oral and written English-language skills in order to mitigate summer learning loss and reduce the achievement gaps in science, mathematics, and literacy. Development of this model would not have been possible without strong collaboration across the departments of Language Culture and Equity, Special Education, and Curriculum Assessment and Instruction. Our theory of action was based on three key principles:

- **Hands-on Science and Literacy Integration**
  The most effective model for science instruction combines the use of hands-on, inquiry-based lessons that are thoughtfully sequenced and supported with a scaffolded approach to writing, discussion, data organization, and vocabulary development.

- **Enrichment, not Remediation**
  Children are natural scientists and bring diverse assets to scientific inquiry. Extended learning opportunities should provide rich, challenging, engaging environments in which students can investigate relevant problems and build academic skills such as writing, reading, and mathematical skills in a scientific context.

- **Inclusion**
  Inclusive learning environments in which students with differing academic challenges engage in the same learning activities with varying levels of support are beneficial to all students. In particular, having both English-language learners and students with significant disabilities learning science together in the classroom should have positive outcomes for both groups.

Our Summer Science Camp spanned six weeks from the beginning of June through the middle of July. The students attended Monday through Thursday of each week from 8:30–11:30 a.m. Students in grades K–7 for the 2009–10 school year were invited to attend the 2010 Summer Science Camp if they were non-English proficient (NEP) or limited English proficient (LEP) on the Colorado English Language Assessment (CELA), or if they qualified for Extended School Year (ESY) services. Students qualifying for ESY typically had an IEP and had demonstrated significant regression over extended breaks from school in the past. Overall, 986 English-language learners and 151 ESY students attended. Fifteen students, all at the same grade level, were assigned to each class with a lead teacher, as well as one or more para-educators to support students with significant needs.

We provided a pacing guide and detailed lesson plans for teachers that specified the learning objectives aligned to our district and state standards as well as learning activities from FOSS, including...
Day 1:
- Kit inventory – **FOSS Variables**
- Start word wall.
- Set up science notebooks.
- Science Notebook Entry: Table of Contents
- Review “Safety in the Classroom” FOSS Teacher Guide Overview, page 17
- Pretest from FOSS Benchmark Assessments
- Read from Delta Reader: Force and Motion “What is a Force?” and “What is Motion?”
- Explore forces and motion on the playground, especially if there are swings.

Day 2:
- Introduce **FOSS Variables** Investigation 1: Swingers, Part 1; follow instructions in the FOSS Teacher Guide.
- Science Notebook Entry: Glossary, have students build their own glossary starting with definitions of “variable” and “pendulum.”
- Go to garden and explore what kinds of variables might exist in the garden (garden variable scavenger hunt); possibilities include type of soil, type of plant, amount of water, frequency of watering, amount of fertilizer, amount of shade/sun, etc.
- Math Extension: Problem of the Week
- Read FOSS Science Stories, *What Scientists Do*

Day 3:
- **FOSS Variables** Investigation 1: Swingers, Part 2; release position; follow Teacher Guide and use science notebook format of question/prediction/data.
  - Science Notebook Entry: Focus Question
    - Give students the focus question “How does release position affect the number of swings?”
  - Science Notebook Entry: Prediction
    - Have students complete sentence frame, “I think that releasing the swinger from a 45˚ angle will make the number of swings, because ___________ .”
  - Science Notebook Entry: Data
    - Have students the following data table in their notebooks and complete in their small group.

<table>
<thead>
<tr>
<th>Number of swings in 15 seconds when released from standard position</th>
<th>Number of swings in 15 seconds when released from a 45˚ angle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 2. Sample Excerpt from Detailed Lesson Plan**

use of the **FOSS Science Stories** and Math Extensions from the FOSS Teacher Guide. We also provided prompts for the teacher to facilitate the classroom discussions, especially the discussion in which the teacher led a whole group analysis of patterns in the data that led to claims and evidence (see Figure 2). Teachers also received a packet of printed vocabulary words in both English and Spanish along with color images representing the words. The teachers used these to construct bilingual word walls. All teachers attended a one-day professional development session, which introduced the instructional model.

Parent, teacher, and student feedback on the 2010 Summer Science Camp was very positive. ESL/ESY Summer School has traditionally focused on mostly math and literacy remediation with a minimal focus on science using FOSS kits. This year, the recruiting materials for summer school emphasized the focus on science, and enrollment increased by 23%. Students completed surveys (in both English and Spanish) at the end of summer camp. Of the 918 students who completed a survey, 95% of students either “loved” or “liked” studying science in summer school; 95% of students also reported that they “loved” or “liked” coming to summer school. Among the things that students wrote they liked the most were “learning new things” and “not being bored.” Parents were not formally
surveyed, but the few calls made to the program staff expressed a high degree of satisfaction, including, “This is the best summer school ever.”

Teachers reported that students were more engaged than in previous years and that they were surprised by the degree of ownership and pride that students took in their science notebooks. Many teachers expressed their intent to continue the work with science notebooks during the regular school year. Although a few teachers expressed concern about the inclusion of the ESY students with the English-language learners before the start of Summer Science Camp, comments were overwhelmingly positive after the program got underway. For students who are often on the receiving end of “help,” having the opportunity to act as helpers to other children was empowering.

Plans are currently underway for 2011 Summer Science Camp, which will include additional FOSS modules: **Air and Weather** at second grade and **Water** at fourth grade. A goal for this year’s program is to include more nonfiction reading linked to the science content and to collect data that will facilitate a more rigorous measure of the program’s success.

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References


After many years devoted to all things scientific, I have become a fairly accomplished observer. One of the most intriguing subjects of my observation has been teachers. Based on data accrued over the years, I have developed a personal profile of attributes common to expert teachers. Expert teaching is supported by three essential pillars of teacher knowledge and personality. Expert teachers:

- have solid knowledge of the content they teach;
- have a deep abiding passion for nurturing developing minds; and
- rigorously monitor their students’ thinking as part of instructional practice.

Essentially, great teachers know what they are teaching and the level to which they expect their students to acquire that content knowledge. They are fascinated and excited by the opportunity to enter into a sacred pact with students to guide and stimulate the development of student minds. They understand that the learning process is fraught with impediments that can stall learning if feedback related to the learning process (formative assessment) is not infused into the process continuously.

This third element of expert teaching is perhaps the most difficult to master. It requires the practitioner to recognize that the act of teaching, even really good teaching, does not guarantee really good learning. Interestingly, this means that the measure of a really expert teacher is not the excellence of the teaching, per se, but rather it is the excellence of the learning.

The FOSS staff spent six years thrashing around in the area of formative assessment. With the help of hundreds of teachers and thousands of grade 3–6 students and advice from expert panels and critical friends (colleagues) around the country, we made some discoveries. First of all, we learned that our “perfect” curriculum, which presented key ideas in a uniform, conceptually coherent learning experience for all students. Individual students integrate new information into their established cognitive constructs in ways that make sense to them, but may fall short of the mental model intended by the curriculum developers. In order to know what’s going on inside a student’s head, student thinking must be made explicit. This is where teaching gets very crafty. It’s not possible, yet, to peer into a student’s ear to see the cognitive wheels turning. The expert teacher finds a way to extract that thinking by inducing students to produce artifacts that are representations of thinking that can be observed and analyzed for evidence of learning. The extracted artifacts can take many forms, including verbal elaborations, graphic representations, and written explanations.

Discussions, graphics, and written work can all be used for valid and informative assessment of learning. These artifacts are all produced as a matter of course during the instructional sequence. Based on student thinking, expert teachers step in to clarify their thinking and assist one another with learning. Typically a misconception is discovered after instruction has been completed, when it can take a great deal of effort to remedy the faulty learning.

Establishing a formative assessment mindset is rather like installing radar as part of your classroom sensory system. Formative-assessment radar can allow you to detect unidentified flying concepts and invisible obstacles in the environment that may interfere with conceptual navigation in the lesson.

Formative assessment is a kind of sensitivity to the progress of learning. Formative assessment is a methodology, a process, not an instrument. Note that the above discussion did not mention giving an assessment, but rather using naturally evolving artifacts of learning as the focal points for formative assessment. Be clear on this distinction. Formative assessment is not a “test” or other evaluative instrument. A considerably aggressive industry calling itself formative assessment has sprung up in the last few years. These products are not legitimate formative assessments; they are examinations intended for use at critical junctures in a course of study. They are designed for two main purposes—standardized test preparation and as predictors for performance on standardized tests. Such disingenuous use of the term formative assessment is detrimental to the valid and effective implementation of legitimate formative assessment practice.

This is not to say that tools that take the form of quizzes and tests cannot be used as part of a formative assessment process, but their use must be constrained to serve the purpose of informing and improving learning and instruction, conforming to the definition of formative assessment.

Formative assessment includes all the activities undertaken by teachers and students that provide information to be used as feedback to modify the teaching and learning activities in which they are engaged. (Modified from the work of Black and Wiliam.)

Expert teachers draw their students into the formative assessment process, too. When teachers create a classroom culture in which students fully understand their responsibility as learners, as the pall of competition is lifted from the classroom, giving opportunity for the light of cooperation to shine through, students feel free to share their confusion in an atmosphere of support and mutual assistance. In such a formative-assessment classroom culture, students engage in peer- and self-assessment to clarify their thinking and assist one another with learning.

Expert teachers keep a finger on the pulse of learning at all times. Constant monitoring keeps the learning from lapsing into a crisis condition, which requires much more effort to remedy than continual small adjustments all along the way.

I recently read an erudite, concise paper written by Margaret Heritage on this subject, *Formative Assessment and Next-Generation Assessment Systems: Are We Losing an Opportunity?* The paper was delivered at a meeting of the Council of Chief State School Officers. I highly recommend this paper to all FOSS teachers and administrators. The text of the paper can be found at http://www.ccsso.org/Documents/2010/Formative_Assessment_Next_Generation_2010.pdf.

Reference

As Larry mentioned in his “Observations” article, FOSS developers have been thrashing around in assessment for at least the last six years. And the results of the thrashing are beginning to take some shape. Through the Assessing Science Knowledge project (ASK), with hundreds of teachers and thousands of students as research partners, we developed an assessment system that we initially saw as having two parts, one formative and the other summative. Embedded assessments, the formative part, would have a narrow focus and occur on a daily basis (whenever a lesson is taught). Benchmark assessments, the summative part, would have a broader focus and happen at the beginning and end of instruction, as is traditional in many curricula, and also occur after each investigation (proposed by the ASK teachers). In benchmark assessments, students would need to differentiate between the various concepts and principles they were learning as well as be able to apply these ideas in a variety of contexts.

**Science Notebooks**

As ASK evolved, science notebooks became a central part of the science inquiry endeavor. We quickly saw that notebook entries provided an excellent context for finding out how students were building their conceptual understanding. Students used the formative assessment prompts as a “writing-to-learn” tool, helping them organize their thoughts and find gaps in their understanding so they could ask questions. Teachers used them to gauge students’ understanding and to plan further instruction. In another project called Formative Assessment in Science through Technology (FAST), we came to the conclusion that students’ writing and thinking in their notebooks provided a more reliable way of looking at student understanding than can be gained through classroom observation and discussion. In fact, we developed a mantra: “If the kids can’t write about it, then they don’t know it well enough.”

It is difficult to use classroom observation and discussion to gauge student understanding for several reasons. First, as you move from group to group, it’s hard to get a handle on who knows what. Once one student has given you a correct answer, you have no real way to gauge the other students’ understanding. Second, in discussion, teachers typically call on a few students and if they are hearing the right things, they assume everyone “got it” and move along. If they hear wrong answers, they ask more questions to scaffold students to the correct understanding. All of these are things that teachers should absolutely do, but it doesn’t give the teacher an accurate picture of what all students are thinking, independent of their peers or the teacher. Further, it often results in teachers having an overly optimistic impression of what the students have learned. This is why specific notebook entries aimed at assessing understanding provide a better tool for gathering reliable evidence of learning. Students do the assessment work as part of the regular lesson, and teachers can look at their work after class, when there is time to read through their responses and thoughtfully reflect on what students are thinking.

“You’re kidding! After class?” you may be thinking. So were all of the teachers in ASK and FAST. They all commented that they got great information about students’ understanding from reading through the notebooks, but it was much too time-consuming. And they weren’t really using the information they got to adjust instruction.

Working together we came up with what we now call the reflective assessment process.

Teachers told us they could spend 10–15 minutes after class to look at student work, but no more. We agreed that they would spend ten minutes looking at student work, followed by five minutes to reflect on trends and patterns and to plan how to adjust instruction for the next lesson. Here are the key steps to make this process work.

- **Anticipate** what is going to be assessed before you begin the lesson. Keep the grand instructional goals and standards in mind (know the place where you are headed), then think about what pieces of knowledge and connections are important in the day’s lesson.
- **Plan** the specific assessment activity. FOSS has tried to make this easy for teachers by making a suggestion in each part of each investigation, then pointing out one or two things to look for in students’ work that will provide evidence about what they know and need help with. Keeping a narrow focus is crucial when it comes to the time factor.
- **Engage** the students in the lesson (the investigation).
- **Review** the students’ work. Students turn in their notebooks open to the page you will be looking at. This is a detail worth mentioning because it can take twice as long to find the page you’re looking for as it does to review a student’s writing. It’s also important to stick with the evidence (not to read anything into the response). If you have any doubt that students understand, assume they don’t fully understand so you can take steps to clarify or help them adjust their thinking.
- **Adjust** instruction as you move into the next investigation part to help students clarify any problems you saw in their conceptual understanding. If you maintain this practice throughout the module, you will need to make only small corrective adjustments along the way. This is much easier than having to make major corrections after multiple misconceptions have accumulated.

Through a synergistic collaboration between the FAST and ASK projects, we completed a very small study that suggests that the reflective assessment process can make a significant difference in students’ performance on summative tests. For further information about that study, which includes more detail about the process itself, see the FOSSweb research database (http://lhsfoss.org/scope/research/search.php) and this article, *Reflective Assessment Technique* (Kennedy, Long, and Camins, 2009).
As mentioned above, the goal was to create summative assessments that would be technically documented so that districts could use them for accountability measures (to supplement standardized tests). But an interesting thing happened as the ASK project proceeded. The benchmark assessments that followed each investigation became known as “I-Checks,” short for “I check my own understanding.” Teachers embraced the opportunity to check their students’ understanding more frequently (rather than waiting for the posttest), but we also found that there was a significant paradigm shift in the classroom culture when I-Checks were used formatively. In other words, students took the assessments, teachers reviewed the student responses, then returned the un-scored, un-marked I-Checks to the students for further discussion and peer- and self-assessment activities. In classrooms that used this process to create a clear dialogue between teachers and students, not only did achievement improve, students’ attitudes towards assessment changed dramatically. Students no longer saw the assessments as a competition. Students were willing to help each other get the “right answers,” and they even began to ask their teachers if it was time to take another I-Check so they could check their understanding. How many times have your students told you they thought it was time to take another test?

Many may ask, “What about the grades we are required to give students?” This is a very good question that we don’t have a definitive answer for at this time. We are currently looking for examples from teachers who are using formative assessment and finding other ways towards assessment changed dramatically. Students no longer saw the assessments as a competition. Students were willing to help each other get the “right answers,” and they even began to ask their teachers if it was time to take another I-Check so they could check their understanding. How many times have your students told you they thought it was time to take another test?

Matthew Wigdahl, a fifth-grade teacher in Eau Claire, Wisconsin, provides us with one example of what can happen in the classroom when grades are not the focus.

I look at the I-Checks before we begin an investigation, so I am sure that I have covered everything the students might need to know to complete the I-Check. When we complete an investigation, I hand out the I-Checks and give the students time to work on them in class. I tell them to work independently and do their very best to try to answer the questions. If students are stalled or confused, I ask them to write an answer using a language stem such as: “I tried doing ___ but it didn’t make sense.” Or, “I need to understand more about ___ to answer the question.” Or, “The most important thing I know about ___ is ___.”

When I-Checks are complete, we go over them in class, sharing ideas as scientists would. The students exchange I-Checks. I emphasize every time that we are not “correcting” the assignment like we used to. We do not mark the questions right or wrong with a big slash through the question! We are seeking to comprehend what a fellow scientist means by her or his answer, and whether she or he understands the question. If the answer is reasonable, and it is clear he or she understands the question, we leave it alone. If it appears he or she might not get it, we write something helpful to clarify his or her thinking. When students raise their hands to ask me if an answer is “right,” I ask them, “do you think that person understands the question?” Usually, they need no further clarification. Students return the I-Checks with no score or grade, just helpful written notes about how to do better. We model and practice what it might look like to go over these notes for review or before a test.

Teachers often express the concern that if the I-Checks aren’t going to be graded, the students won’t take them seriously. Matthew has found the opposite to be true. In fact, he reports that his students take the process very seriously and discuss the concepts thoughtfully and in a mature way.

One thing some people have been skeptical of is how I might hold students accountable for incomplete or missing work if I don’t collect/correct the assigned I-Checks myself on the due date. Emphasizing understanding over the responsibility of being prepared (a separate skill to be taught in my opinion) has sharpened our focus on science. While there may be a few students who are not finished with their I-Checks on the day we go over them, it has been much less of a problem than in other subjects. I explain that they lost the opportunity to check their understanding but should still participate in the exchanging and discussion of the I-Checks. I believe this has helped shift the motivation for completing assignments from external consequences to an internal desire to learn.

Matthew has taken formative assessment to the core of his instructional practice. He has clearly transferred the responsibility for learning to his students and is using the assessments as a learning tool; students are responding in a very positive way. This is evidence that understanding and not grades can be a very motivating experience for students.

As Larry mentioned in his “Observations” article, formative assessment has become quite an industry. Unfortunately, many educational publishers have misinterpreted the essentials of formative assessment simply to create a product. At FOSS, we believe that formative assessment is the process that teachers and students use in order to enhance the dialogue among them to improve learning. It requires thoughtful planning and reflection, but the payoff is tremendous.

Reference
This issue's Wordsmiths column focuses on some books that take a look at some tiny earth materials—sand and dust. If you have found a book that you think other FOSS users should know about, please send the reference to foss@berkeley.edu, including author, title, ISBN, and a short annotation.

Sand

In the FOSS Pebbles, Sand, and Silt Module, students discover that sand is a word used to describe a size of rock. But where does sand come from? Geologist Ellen Prager exposes some of the mysteries of sand in this book. Using colorful and whimsical illustrations, she describes how water, wind, ice, and other processes of erosion help create sand. She describes the various earth materials that make up sand, including rock, coral, and crystals. Photomicrographs provide readers with close-up views of beautiful sand samples. (Pebbles, Sand, and Silt Module; Solid Earth Module; Landforms Module)

Sand: The Never-Ending Story

The preface of this book begins with a quote from the movie, Eternal Sunshine of the Spotless Mind.

Sand is overrated—it’s just tiny little rocks.

Sand may be overrated to some, but to geologists and FOSS students it is an important earth material. The stories told by a sample of sand provide a glimpse into events that have changed Earth's surface over billions of years. Welland, a British geologist, delves into the study of sand full-throttle. Using Wentworth's definition of sand, he focuses on particles ranging in size from very fine sand, 0.0625 to 0.125 mm, to very coarse sand, 1–2 mm. He discusses all of the various earth materials from which sand originates, including quartz to microfossils. He explains how much sand is part of geology, biology, and human history. A grain of sand is followed down the Susquehanna River to the ocean depths. From the strange fluid mechanics of moving sand to fascinating sand art, Welland exposes the never-ending story of sand in a way that should capture just about anyone's attention. (Earth History Course; Landforms Module; Solid Earth Module)

Continued on page 16
A Grain of Sand: Nature's Secret Wonder
The Amazing Microphotography of Dr. Gary Greenberg

To see a world in a grain of sand,
And a heaven in a wild flower,
Hold infinity in the palm of your hand,
And eternity in an hour.

William Blake, Auguries of Innocence

Greenberg opens his book with this quote from William Blake and then invites into the close-up world of sand. Using microphotographic techniques that he developed, Greenberg gives us an almost three-dimensional view of sand, its colors, textures, sizes, and shapes. The story of sand unfolds through text and photographs. Sand becomes an art form through his amazing photographs. Even young students will appreciate these images; older students and adults will find the text useful in expanding their understanding of the world of sand. (Pebbles, Sand, and Silt Module; Landforms Module; Solid Earth Module; Earth History Course)

The Secret Life of Dust: From the Cosmos to the Kitchen Counter, The Big Consequences of Little Things

Think about it. If it weren’t for dust, water vapor wouldn’t start to condense until the relative humidity was about 300 percent. This is just one piece of information provided by Hannah Holmes as she unearths the story of dust. To most of us, dust is just a nuisance that gathers on top of surfaces in our homes just waiting to be wiped off and moved to a new location. Most dust is well traveled—between one and three billion tons of desert dust fly up into the atmosphere each year. To put that in perspective, one billion tons of dust would fill 14 million boxcars, in a train that would wrap around Earth’s equator six times! Chapters continue with discussions of planetary evolution, allergies, dinosaurs, lung disease, and pollution, to name a few. The book includes a detailed bibliography, as well as a listing of websites for each chapter so that readers may continue their exploration into the world of dust. (Earth History Course)

Wordsmiths continued

NEW RELEASE

The Role of Public Policy in K–12 Science Education

Linda De Lucchi and Larry Malone, co-directors of the FOSS Project, have co-written a chapter entitled “The Effect of Educational Policy on Curriculum Development: A Perspective from the Lawrence Hall of Science” as part of this publication. The goal of this volume of Research in Science Education is to examine the relationship between science education policy and practice and the special role that science education researchers play in influencing policy. It has been suggested that the science education research community is isolated from the political process, pays little attention to policy matters, and has little influence on policy. But to influence policy, it is important to understand how policy is made and how it is implemented. This volume sheds light on the intersection between policy and practice through both theoretical discussions and practical examples.

This book was written primarily about science education policy development in the context of the highly decentralized educational system of the United States. But, because policy development is fundamentally a social activity involving knowledge, values, and personal and community interests, there are similarities in how education policy gets enacted and implemented around the world.

This volume is meant to be useful to science education researchers and to practitioners such as teachers and administrators because it provides information about which aspects of the science education enterprise are affected by state, local, and national policies. It also provides helpful information for researchers and practitioners who wonder how they might influence policy. In particular, it points out how the values of people who are affected by policy initiatives are critical to the implementation of those policies.
Exciting Changes Coming to FOSSweb!

Next fall, FOSSweb will have a brand new site design! We are redesigning the site to make it easier for teachers, parents, and students to find and use all of the valuable FOSS resources found on FOSSweb.

Some of the planned changes include:

- Easy access to eBooks and eGuides,
- Resources for each module available on the same page,
- Interactive whiteboard resources, and
- Class notes and assignments.

In order to take advantage of the new and enhanced resources, FOSSweb users will register for an account and log in to the site. Therefore we are encouraging our existing users to sign up now to receive important FOSSweb updates. By signing up, we’ll keep you informed about when the new site will launch and send you important information on how to register for an account.

Please go to FOSSweb.com, FOSSweb.com/CA, or FOSSweb.com/NYC to sign up to receive important FOSSweb updates!

NEW FOSS eBooks and eGuides Available Now!

Electronic versions of the FOSS Teacher Guides and student Science Stories and Science Resources books are now available for purchase. The eGuides are complete FOSS Teacher Guides, including all investigations, in an electronic web-based format, allowing 24/7 access from any Internet-enabled computer. Teachers can do their preparation at home or school; no binder is required! If your district rotates modules or courses among several teachers, this option allows all teachers easy access to the all-important Teacher Guide at all times.

The student eBooks provide access to the FOSS Science Stories and FOSS Science Resources books from any Internet-enabled computer. The eBooks look identical to print resources, with easy to turn pages and a chapter menu for easy navigation. The student eBooks include audio clips of the book text on every page and highlighted vocabulary words with pop-up definitions. The student eBooks ensure all students receive extra reading support.

Please contact your Delta Education sales representative for more information about the FOSS eGuides and eBooks, including pricing and ordering. Spanish* and California edition eGuides and eBooks are also available.

New Taking FOSS Outdoors Video and Folio available on FOSSweb

As a part of our outdoor initiative, we recently added a Taking FOSS Outdoors folio and the Science in the Schoolyard™ video, a work produced by the Boston Schoolyard Initiative, to all modules on FOSSweb and FOSSweb/CA. The folio gives you general guidance for taking your students outdoors, including choosing a study site; managing time, space, students, and materials; and general teaching strategies. The video has footage of teachers and students taking science outdoors, and demonstrates both practical tips for taking your class outdoors and strategies for managing time outside.

To access the folio or video, navigate to the FOSS module you are using, click the For Teachers and Parents icon, and then choose Teacher Resources. Click the ladybug icon to see all the Taking FOSS Outdoors resources for that module.

FOSS on Facebook and Twitter!

Do you use Twitter or Facebook? Follow or be a fan of FOSS online. The FOSS social media networks are an easy way for FOSS users to get the latest news from FOSS, including teaching tips, FOSSweb updates, professional development opportunities, articles about good educational practices, and science news articles relevant to FOSS modules. Join in conversations with FOSS developers and FOSS teachers from across the country. Provide updates about what’s working in your FOSS classroom. And let everyone know what’s caught your attention in the latest FOSS Newsletter!

If you are a Facebook user, you can become a fan of FOSS at http://www.facebook.com/FOSSscience.

Twitter users can follow FOSS updates at http://www.twitter.com/FOSSscience.

*Spanish student eBooks are available, but do not include audio.
ASA news releases in January and February 2011 announced the following exciting discoveries.

❍ January 10: Kepler mission confirmed the discovery of its first rocky planet, named Kepler-10b, 1.4 times the size of Earth—the smallest planet ever discovered outside our solar system.

❍ February 2: Kepler mission releases data from the first four months of continuous simultaneous observations of 156,000 stars in Lyra and Cygnus, including evidence for 1,235 new planets. What’s even more exciting is that 54 new planet candidates are in the habitable zone of their star (where liquid water can exist) and of those, five are near Earth-sized. The remaining 49 habitable zone candidates range from super-Earth size to larger than Jupiter. It’s possible they could have habitable moons.

❍ February 2: Kepler mission announces the discovery of six planets orbiting a sun-like star, Kepler-11. This is the largest group of transiting planets orbiting a single star yet discovered outside our solar system. Kepler-11, located approximately 2,000 light years from Earth, is the most tightly packed planetary system yet discovered. All six of its confirmed planets have orbits smaller than that of Venus, and five of the six have orbits smaller than Mercury’s.

IN THE NEWS: NASA’s Kepler Mission Discovers Its First Rocky Planet and a Cornucopia of Planet Candidates

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“All of Kepler’s best capabilities have converged to yield the first solid evidence of a rocky planet orbiting a star other than our sun,” said Natalie Batalha, Kepler’s deputy science team lead at NASA’s Ames Research Center in Moffett Field, California, and primary author of a paper on the discovery accepted by the Astrophysical Journal. “The Kepler team made a commitment in 2010 about finding the telltale signatures of small planets in the data, and it’s beginning to pay off.”

Kepler’s ultra-precise photometer measures the tiny decrease in a star’s brightness that occurs when a planet crosses in front of it. The size of the planet can be derived from these periodic dips in brightness. The distance between the planet and the star is calculated by measuring the time between successive dips as the planet orbits the star.

Kepler is the first NASA mission capable of finding Earth-size planets in or near the habitable zone, the region in a planetary system where liquid water can exist on the planet’s surface. Though Kepler-10b is the first rocky planet discovered outside the solar system, it’s definitely not in the habitable zone. A “year” on Kepler-10b is less than one Earth day! It orbits once every 0.84 days and is more than 20 times closer to its star than Mercury is to our Sun, so its temperature is over 1,800 °C, hot enough to melt iron. Nonetheless, “the discovery of Kepler 10-b is a significant milestone in the search for planets similar to our own,” said Douglas Hudgins, Kepler program scientist at NASA headquarters in Washington, D.C. In a New York Times article on February 2, 2011, after the Kepler data release announcement, Dennis Overbye wrote, “Astronomers have cracked the Milky Way like a piñata, and planets are now pouring out so fast that they don’t know what to do with them all.”

The FOSS Planetary Science Course, Second Edition, to be released in Fall 2011, culminates in an investigation about finding exoplanets, featuring the technique used by Kepler mission: observing transits of the planets in front of their stars.

For more information about the Kepler mission, visit:
http://kepler.nasa.gov.

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How to Submit an Article for the FOSS Newsletter

Have you ever thought about submitting an article to the FOSS Newsletter? The newsletter is published twice a year, with deadlines in June and December. Have you conducted some research or developed a project that focuses or includes FOSS? Are your students doing something exceptional with FOSS that you would like other readers to hear about? Have you extended the FOSS investigations to something of interest in your community? If so, we would love to hear from you.

Here’s what you need to know to submit an article.

❍ Let the editor know that you are planning on submitting an article. The contact information is listed on the back page of this newsletter.

❍ Submit the article as a text file without formatting. It helps if the text file can be opened in Microsoft Word.

❍ Submit all images (graphics, illustrations, photos) as separate high-resolution files. Digital images should be at least 300 dpi.

❍ Provide captions for any images.

❍ Make sure you have completed consent forms for any individuals (both students and adults) that appear in the images. You can download the FOSS consent form at http://lhsfoss.org/newsletters/contribute.html.

If you have any questions about article submission, please contact Sue Jagoda at skjagoda@berkeley.edu. The deadline for submissions to the next issue is June 10, 2011. We’re waiting to hear from you.

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FOSS Institutes

Delta Education will host two one-day FOSS Institutes before each of the three regional NSTA Conferences in Hartford, Connecticut (10/26); New Orleans, Louisiana (11/09); and Seattle, Washington (12/07). These Institutes, one for K–5 and one for middle school, will be for educators from districts that have implemented FOSS or are planning to implement FOSS. The Institutes will focus on newly developed FOSS materials—new FOSS K–5 modules for 2012 and Planetary Science Second Edition for Middle School. These Institutes are designed for experienced FOSS educators—lead teachers, administrators, curriculum coordinators, professional developers, and university methods instructors.

These Institutes are free, but you must register in advance to attend. To secure your spot at the Institute, please write, fax, or e-mail:

Pam Frisoni
Delta Education
80 Northwest Boulevard
Nashua, NH 03063
pam.frisoni@schoolspecialty.com
Fax: 920.882.4598

FOSS CA Newsletter E-blasts
Are you a teacher using the California edition of FOSS? Sign up to receive the FOSS CA newsletter e-blasts today! The FOSS CA newsletter e-blasts will be delivered biannually to your e-mail inbox and feature content specific to the FOSS California edition. To sign up for the newsletter, visit www.FOSSweb.com/CA and click on the e-blasts button.

FOSS Newsletter
Would you like to receive the FOSS Newsletter electronically? Simply sign-up at www.deltaeducation.com/science/foss/newsletter.aspx or send your request to jason.crowell@schoolspecialty.com. Include your name, title, school, and e-mail address. You can also view both the recent and previous issues of the FOSS Newsletter, as well as archived articles, at www.lhsfoss.org/newsletters.

If you’d like to be added to the mailing list to receive this newsletter by mail, please send your name and address to:

Jason Crowell
Delta Education
80 Northwest Boulevard
Nashua, NH 03063
jason.crowell@schoolspecialty.com
Phone: 603.579.3435

NSTA 2011 NATIONAL CONFERENCE
San Francisco, CA March 9–12, 2011

FOSS staff and consultants will be presenting a number of workshops at the NSTA national conference in San Francisco, including field trips, sessions on formative assessment and use of notebooks, taking FOSS outdoors, and exploring language development through inquiry. For a complete list of the FOSS-related presentations, go to www.FOSSweb.com and check the News. The sessions are also listed in the online Professional Development Calendar at www.FOSSweb.com.

FOSS will also be presenting sessions at each of the Fall 2011 NSTA Conferences.

Hartford, CT October 27–29
New Orleans, LA November 20–13
Seattle, WA December 8–10

Summer 2011 Calendar
Middle School Institutes

June 28–July 1 (Tuesday-Friday)
FOSS Planetary Science (Second Edition) Institute
Location: Lawrence Hall of Science

July 19–24, (Tuesday-Sunday)
FOSS Populations and Ecosystems Institute
Location: Lawrence Hall of Science and Mono Lake, CA

For more information about these middle school institutes, please contact Jessica Penchos at jessica_penchos@berkeley.edu or 510.643.5145.
About This Newsletter . . .

The intent of the FOSS Newsletter is to help FOSS users develop a network of support across the country. Delta Education and LHS will work together to bring you news two times per year, including articles regarding the latest development of modules, tips about management from teachers and administrators, ways to make connections with other teachers and districts, extensions and reading materials to add to modules you are already using, and informative articles about good educational practices.

So, we need your help. If you have a tip that enhances the teaching of FOSS or would like to submit an article (with photos) about exciting activities or school programs, management, implementation projects, etc., please send them in. We would also like to hear from your students, whether they have questions about the content, projects they have done, photos or other images they have created, or insights into how they use the Internet with FOSS. Send your contributions to:

Sue Jagoda, Editor (skjagoda@berkeley.edu)
FOSS Newsletter
Lawrence Hall of Science
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The deadline for submissions to the next issue is June 10, 2011. We’re waiting to hear from you.

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See you at the NSTA National Conference in San Francisco, March 9-12, 2011!

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