The new FOSS Third Edition has made its debut and is available for implementation in 2012. How did it all begin? In 1988, the Full Option Science System proposal was submitted and funded by the National Science Foundation. The NSF guidelines stipulated that awardees were to develop comprehensive science curriculum materials appropriate for guiding American K–6 science education effectively into the 21st century. In other words, the programs were to bridge the last decade of the 20th century into the unknown vision of science in the looming 21st century. Daunted by the magnitude of the expectation, we wrote a proposal to develop a comprehensive curriculum for grades 3–6, leaving science for the primary students for others to tackle or at least to postpone that adventure until we dealt with the intermediate gang. With NSF funding and a development staff of four at the Lawrence Hall of Science, we plunged in. After the three years we were allotted to get the job done, we had 16 modules for our target audience. We immediately wrote a follow-on proposal to develop the FOSS program for the little guys, FOSS K–2. With an additional three years of funding, we launched ourselves into the primary classrooms, and in 1995, we completed that work. Now we had the desired comprehensive K–6 curriculum. FOSS watchers will remember the black-binder teacher guides that we called simply FOSS, but with the advantage of hindsight, we now refer to it as the FOSS First Edition.

The wheels of fortune turned, and success was sufficient to keep us interested in the continued progress of the program. By the time the 21st century was imminent, it was clear that FOSS needed some attention. The National Science Education Standards (NSES) were finalized in 1996, and it was important to show the FOSS alignment with NSES. The elementary education profession was becoming increasingly vocal regarding the need for student reading, and calls for accountability were building. It was clear that in order to continue to grow...
FOSS Third Edition continued

the impact of the program, FOSS would need to be revised. In the late 1990s, we began working to update FOSS, developing a series of companion readers for the FOSS modules—FOSS Science Stories—and at the same time codifying what we knew about assessment of student learning. When we had amassed these two resources, we revised FOSS, incorporating companion readers and refined assessment materials into each module. We gave the teacher guides fresh visual appeal with full-color images on the covers and grade-band color coordination—gold was for K–2, blue was for grades 3–4, red was for grades 5–6. This is known now as the FOSS Second Edition. This is the edition, released in the year 2000, that represented the final anchorage of that envisioned bridge to the 21st century.

The Second Edition carried us into the 21st century. In 2005, it went through a minor revision, and in 2009 a few new modules were added based on the development work for the FOSS California Edition. But after arriving in the new century and getting the measure of the environment for elementary science, it became clear that it was time to revise FOSS yet again. After convening a few focus groups around the country with both experienced and novice FOSS users, compiling humongous spreadsheets of state science standards around the country, and careful monitoring of the various efforts to produce a new national framework for science education, it became clear that a revision of the existing program might not get the job done. The new project that we agreed to undertake is more like a reinvention of FOSS than a revision of the program.

We started the Third Edition writing process in 2007, this time with a staff of a dozen developers. We were hampered by one major factor. The new national science framework and standards, that ultimately would have tremendous impact on the acceptance of the new program, were still several years away. Undaunted, we forged on, confident that we could anticipate the direction of the new vision of science education. As we started the design process, we drew upon the research we had conducted in ASK (Assessing Science Knowledge, funded by NSF 2002–2006), recent work on learning progressions, and the advice from respected colleagues who were experienced in implementing FOSS.

So What’s the FOSS Third Edition User Experience?
We knew the FOSS Third Edition would have several new critically important design features to support and enhance active investigation, including:

1. Totally integrated use of student science notebooks in the active investigations;
2. An all-new formative assessment system with online assessment tools to inform instruction;
3. Thoroughly integrated use of the outdoor, schoolyard environment in every module;
4. A completely redesigned and expanded FOSSweb.com (FOSSweb 2.0) to bring digital resources to teachers, students, and families; and
5. New emphasis on language arts development—science-centered language development with fully revised student reading materials—module-specific Science Resources books.

Some elements of the traditional FOSS experience remain unaltered in the Third Edition. Students still learn science by
doing science. The active investigation with objects, organisms, and systems still constitutes the signature student experience. The three original FOSS goals survived intact. The goals are the same, but the interpretation concerning what meeting the goals entails have been modernized. The goals are:

1) Scientific literacy for students;
2) Instructional efficiency for teachers; and
3) Systemic reform for schools.

**What Will I See that Is Different?**
The ever-expanding three-ring binder teacher guide has been replaced with two smaller documents. These two documents—Investigations Guide and Teacher Resources—along with the FOSS Science Resources book for students, make up the module Teacher Toolkit. The module Investigations Guide is a spiral-bound collection of instructional chapters; it includes the module Overview, the module Materials chapter, and the Investigation chapters. Second is a smaller Teacher Resources binder that holds several classes of information that relate to FOSS teaching practices. These chapters and sections are also available online as digital resources and include chapters on:

- Using science notebooks;
- Taking FOSS outdoors;
- Assessment;
- Science-centered language development; and
- Notebook masters, teacher masters, and assessment duplication masters.

The Third Edition user will note immediately that the module Teacher Toolkit is produced in full color. Color makes the experience more inviting, and color is used to convey information throughout the investigation write-ups. An important new pedagogical feature of the Third Edition is the use of focus questions. Each part of each investigation is guided by a focus question, which is made explicit at or near the beginning of each part of each investigation. The focus question makes explicit for both students and teachers what is expected in terms of understanding by the end of that part. Students always express their understanding by writing an answer to the focus question in their notebooks. The scientific background for the teacher at the front of each Investigation chapter is organized by focus question, so it will be easier than ever to find the specific background information needed for each part of each investigation.

A set of icons is used to alert the teacher to different classes of information. Icons are used to call out junctures where students should make an entry in their science notebooks, places where students should be allowed to discuss an experience with others in their group, places where student work or scientific practice should be assessed, junctures where students should read an article in their Science Resources books, safety concerns, time to form an orderly procession and go outside for an outdoor investigation, and locations in the investigation where new vocabulary words should be introduced formally.

The concluding summary following each part of each investigation is now called Wrap-Up/Warm-Up, suggesting that

*Continued on page 4*
FOSS Third Edition continued

The FOSS Third Edition modules are organized into three domains: physical science, earth science, and life science. Each domain is divided into two strands, as shown in the table for the FOSS Elementary Program. Each strand represents a core idea in science and has a conceptual framework. The sequence in each strand relates to the core ideas described in the national framework. Modules at the bottom of the table form the foundation in the primary grades. The core ideas develop in complexity as you proceed up the columns.

- **Get Out!**
  You may wonder about trekking outdoors... is it really important or an optional enrichment? The Third Edition is designed with fully integrated outdoor experiences for at least two reasons. First, classroom science learning has tremendous value, but in the final analysis, the concepts and principles exposed in the carefully designed classroom activities are actually at work and naturally expressed in the real world. Discovering that knowledge acquired in the classroom has real-world application is the ultimate payoff. And bringing science to life as fully functional knowledge is one of the implicit goals of STEM literacy, one of the emerging societal goals of education (see Observations by Larry, page 15). A second reason for going outdoors is to bring students into at least a minimal contact with nature. It is important for students to see wildlife, feel the breath of the environment, and maybe, just possibly, observe something awesome or beautiful in the outdoors. Developing a relationship with nature is a hope we harbor for each and every student who is touched by FOSS. And research reveals time and time again that some students are motivated and focused by opportunities to learn in non-traditional classroom settings. You may find that some of your behaviorally challenged students are able to excel in outdoor learning environments.

- **Peek into the FOSS Digital World**
  You will discover the Third Edition has a whole new digital presence. FOSSweb is the pivot point around which all of the digital wonders revolve. When you navigate to the new FOSSweb, you will see a new look and find a host of new features and services (see FOSS Tech Corner, page 18). After you register, you can customize your home page to welcome you to your modules every time you return. You will immediately have access to all the resources associated with the modules you are currently teaching, including news updates, digital classroom resources (projectable notebook sheets, streaming-video selections, audio books, and multimedia interactive activities and simulations). In addition, you will find an electronic version of the Investigations Guide, making it possible to do lesson preparation at home or elsewhere without toting around the print copy of the Investigations Guide. The chapters in Teacher Resources are also available online. There is a secure space for you to post messages to your students (and families) who may be using FOSSweb at home. Another feature includes module-specific tutorials to help struggling students and students who may have been absent when an important investigation was conducted. In the near future, upper elementary students will be able to use FOSSmap to take their benchmark assessments online. The assessments (survey/posttest and I-Checks) will be automatically coded, after which a large variety of progress reports can be immediately generated, providing information about student learning and diagnostic data for guiding next steps in instruction. FOSSweb will also be your access point to interactive whiteboard (Smartboard™ and Promethean™) slides and flipcharts designed for your module, allowing you to use your interactive whiteboard to manage and organize your FOSS module instruction for grades 3–6.

So what does it all add up to? The Third Edition of FOSS is the same high-quality FOSS, but much more than just primped and dressed up in 21st century garb. The pedagogy has been modernized with the addition of student science notebooks and embedded formative assessment. These two features drive the FOSS classroom experience in a new direction... toward a much more dynamic and enriched relationship between learners and between teachers and learners. The new FOSS classroom culture honors the implicit quest for deep understandings of the natural and designed worlds and encourages cooperation and collaboration among students as they strive to help each other make sense of their experiences. 🌿
As winter transitions into spring and life that has lain dormant or traveled elsewhere returns to schoolyards across the country, exciting opportunities for learning develop just outside the school building’s walls.

Research has shown that academic performance is enhanced when classroom learning includes meaningful experiences in the schoolyard and beyond. Connection to nature and place stimulates higher order cognition, motivation, citizenship, and self-confidence when the content is developmentally appropriate. Whether moving a FOSS activity outdoors “as is,” modifying activities to take advantage of the outdoor environment, or extending an investigation by going outdoors, using the schoolyard offers many opportunities for concept application and knowledge expression.

After spending much of their time in the indoor classroom during the winter, students can get antsy and struggle to stay focused. If you have the flexibility, you can strategically insert an outdoor activity during testing weeks, which can be grueling for students. Interjecting an outdoor experience before or after testing sessions can refresh and invigorate students.

Many things will happen to your schoolyard between the winter break and the end of the year. The following activities are part of an outdoor program called Outdoor Biology Instructional Strategies (OBIS, http://www.outdoorbiology.com/) and offer fun, quick, affordable, and rewarding opportunities to investigate ecological relationships in the local environment.

**Early Spring: Opportunities in Snow**

- **Tracking.** A snow-covered schoolyard offers many opportunities for exploring animal footprints. How many different tracks can you find? What can you infer about animal behavior based on the path of those tracks? In the Scent Tracking activity, students use spray misters and liquid extract to simulate the undetected world of scent tracks and engage in an activity in which predators track prey by following its scent. Consider this activity as a great exploration of animal behavior and interactions as connected to FOSS modules.

- **Thermoregulation.** Spring can be a difficult time for animals to survive as plant food sources are depleted and freezing temperatures persist. Animal Anti-Freeze explores strategies animals use to stay alive in these conditions. Students search for hibernation and shelter sites that will protect gelatin “animals” from freezing. This is a great application of concepts learned through FOSS about animal adaptation.

**Connecting Phenological Studies to OBIS**

Phenology is the study of cyclic seasonal changes of living things in response to weather factors and climate. In a world where the status...
Teaching Outdoors continued

quo is being impacted by climate change, students can experience and monitor annual changes in plant cycles or animal behavior—budding, blooming, and migration.

- **Plant Budding: Project BudBurst** ([http://neoninc.org/budburst/](http://neoninc.org/budburst/)) is a network of people who monitor plants in relation to seasonal changes. Students can participate by adding simple data to the national database that informs researchers about “the responsiveness of individual plant species to changes in weather changes locally, regionally, and nationally.”

- **The USA National Phenology Network (USA-NPN)** ([http://www.usanpn.org/](http://www.usanpn.org/)) monitors the influence of climate on the phenology of plants, animals, and landscapes. It provides a clearinghouse for educators that houses educational materials (lesson plans, activity guides, syllabuses, project design plans) to provide resources on phenology learning both inside and outside of the traditional classroom setting. Older students and teachers may sign up to participate as observers and recorders of animal activity and plant development in their communities.

- **Monitoring Bird Migration: Project Feeder Watch** ([http://www.birds.cornell.edu/pfw/](http://www.birds.cornell.edu/pfw/)) is a winter-long survey of birds that visit feeders throughout North America from November through early April. Students count the birds they see at their feeders and send their observations to the national database to help “scientists track broad-scale movements of winter bird populations and long-term trends in bird distribution, abundance, and movement.”

**Late Spring: Summer Biodiversity**

As the year draws to an end, counteract cabin fever by incorporating local biodiversity into your studies. These OBIS activities focused on biodiversity provide meaningful experiences for authentic writing and art, beyond scientific understanding. Students can

- survey and catalog the organisms that live in your schoolyard with Plant Hunt, Animals in the Grassland, What Lives Here? and The Old White Sheet Trick;
- measure distribution with Plant Patterns and Stickers;
- measure abundance with How Many Organisms Live Here? and Bean Bugs; and
- compare the biodiversity in managed and unmanaged sites with Out of Control and Animal Diversity.

**Taking FOSS Outdoors**

FOSS recommends that teachers use live organisms for scientific study in their classrooms. Using organisms for scientific observation takes a bit more effort, but the rewards of first-hand experience with life, by students who may have never had the opportunity to work with live animals, are invaluable. In several FOSS modules, Animals Two By Two, Structures of Life, Environments, and Diversity of Life, students set up small aquariums containing a community of fish, crayfish, plants, and small invertebrates—a model ecosystem.

Live organisms motivate students in many ways. They provide students a chance to exercise responsible caring behavior, to observe life cycles, and to appreciate the essential factors that nurture life and sustain a viable habitat. In addition, students will learn how organisms in their small aquatic habitat can impact outdoor ecosystems if they escape, unless thoughtul steps are taken to prevent relocation into local aquatic systems. FOSS endorses the NSTA Guidelines for Responsible Use of Animals in the Classroom (http://lhsfoss.org/fossweb/teachers/materials/platanimal/ethics.html). Teachers should read the guidelines prior to investigating and discuss with students the responsible way to recycle aquatic systems.

FOSS is currently working with the Oregon State University Invasive Species Program, Oregon Sea Grant Extension, and U.S. Fish and Wildlife Service to educate the teaching community to never release classroom organisms into the environment. Invasive species are organisms that are not native to the local environment, but which thrive when introduced into a new environment. Nonnative aquatic species become invasive when they outcompete native species and cause mischief when they change the population dynamics of the system. They threaten the diversity of native species and displace local species. Another related national effort to educate the public is Habitattitude™, a joint project involving the pet and nursery industries and environmental agencies. Habitattitude instructs pet and pond owners on the proper way to care for and dispose of unwanted or extra aquatic organisms.

FOSS recommends effective practices for disposing of aquaria so that nonnative species don’t find their way into the outdoor environment. Because FOSS aquaria are closed environments, one-quarter of the water should be cycled out (replaced) weekly to mitigate the effects of the concentration of nitrogenous waste products. Make sure to have a supply of dechlorinated water on hand. If your local water is treated with chlorine, water can be prepared by simply letting it stand in an open container for 24 hours or more to outgas the toxic chlorine gas. If your water is treated with chloramine, the water supply will have to be chemically prepared using a commercial product specifically formulated to counteract the chloramine, which can be toxic to many aquatic organisms. FOSS provides this product with the life science kits, and it can be purchased as a line item from Delta Education.

While student groups are busy observing and maintaining their aquaria, add water maintenance to their schedule of responsibilities. When removing water, always dump water from the aquarium into a sink, so that the waste products from the tanks are processed by the local sewage plant. As an alternative, wastewater from the aquarium can be used to water indoor plants when there is no possibility that the wastewater can stray into natural aquatic systems. It is not a good idea to dump aquarium water on grass or into storm drains in street gutters. Water in storm drains is usually not processed as wastewater and often flows directly into local creeks, rivers, and bays. To keep your tank clean, wipe the sides of the tank with an algae-scrubber pad every time you maintain the water.

At the conclusion of your class’s investigation, it may be necessary for the tanks to be dismantled. Even though this is an unpleasant aspect of the investigation, remember and value your students’ important experiences nose to nose with life. When cleaning up the aquarium, the best alternatives are either to keep organisms as permanent members of your classroom or to let another classroom use them. Check with your local pet stores, animal supply groups, or local science and nature centers to see if they can use the organisms. If you must dispose of the organisms, first euthanize them. A quick, effective way to accomplish this goal is to put the organisms in a plastic bag and keep them in a freezer for 48 hours. Dispose of the dead organisms in the trash. Never release living organisms into the wild.

The swamp crayfish, some snails, and some water plants are considered aquatic invasive species. Disposing of them responsibly will ensure that you are not introducing pests into your environment. When you are disposing of the aquarium water, separate plant material from the water, so that only water goes into the sink. For snails and plants, either freeze them for 48 hours or put them in a bucket and cover with boiling water. This will neutralize algae and snail eggs, too. Then place the material in a plastic bag, and dispose of it in a garbage can.

Best wishes for enjoying your living, growing, safe, and successful FOSS aquariums!
Many schools are using FOSS to do some amazing things with their curriculum, improving students’ scientific practices and science content knowledge. They are also advancing language literacy by integrating science and English language arts, developing basic language proficiency by scaffolding science lessons to support English-language learners, and exercising math skills and concepts by teaching math in context as a fundamental way to think and process information in the enterprise of science. Very deliberate processes have moved these schools and their students to higher levels of achievement. Here’s what is happening at two FOSS schools.

**Bell Gardens Elementary School**

Picture a classroom of 44 fourth graders, including several with special needs, and one teacher. No classroom aides. The classroom is typically cramped and crowded, desks pushed together with only narrow aisles between, no room for a group table or rug to use as a gathering place. Furnishings that date back to the 1960s are well-organized and neat but definitely showing the patina of age. Almost all of the students are learning English as a second language, struggling not only with the academics, but also with the language. This is Leslie Hiatt’s class at Bell Gardens Elementary School in Montebello Unified School District near Los Angeles.

When it’s time for FOSS lessons, one student from each table group retrieves science notebooks. Ms. Hiatt projects a series of slides to guide a brief review of the last lesson. She asks mostly integrating questions, and students respond using science content and newly acquired academic science vocabulary. Ms. Hiatt records responses for all
students to see. She then introduces the lesson for the day, often using one or more kinds of visual scaffolding. Most materials for the investigation are already in large tubs in the centers of the tables, but the getter from each group retrieves any additional materials needed from the materials station. Students stop and discuss their observations with their table partners or their table groups at appropriate junctures in the investigation.

After discussion, students write in their science notebooks, recording what they have learned to this point. Sometimes they draw a line of learning to add to or modify an earlier notebook entry. We see a lot of doing, speaking, writing, revising, recording observations, and cycling back to do it again and again. Science and language are taught and reinforced through many modalities. At the appropriate point in the lesson, Ms. Hiatt introduces the focus question, being careful not to disrupt the intensity of the students' pursuit of discovery, but rather to reinforce the objective for student learning for the lesson. The focus question reinforces the big idea or understanding that she wants to be sure the students understand and can communicate both orally and in writing. For this lesson, the question is: What is granite, and what minerals does it contain? By the end of the lesson, all students have answered this question in their science notebooks, using words and drawings. They are confident in their use of academic language. They are confident in their observations, their writing, their record keeping, and their scientific illustrations. This classroom is spilling over with the intensity of learning science!

In addition to learning great science and English/language arts, these students are developing proficiency in English as a second language. The California assessment for English competency is the California English Language Development Test (CELDT). Historically, students often get stuck at a middle level on this test even in high school. They must score at an advanced or early advanced level to achieve the opportunity to exit the English-language learner (ELL) program and participate in a fuller curriculum. Because of time spent in ELL classes, they may miss other important subjects and definitely don't have time for enriching electives that often serve as motivators to keep students interested in school. In California, getting students to ELL program exit levels as determined by the CELDT has been a challenge for many years.

The process of changing the situation for students at Bell Gardens began with a California Postsecondary Education Commission (CPEC) grant in collaboration with the K–12 Alliance. This CPEC project supported teacher collaboration to plan how to incorporate language development strategies with hands-on science lessons. Jo Topps, the K–12 Alliance project leader, facilitated the development of collaborative teams to learn about and plan the lesson integrations. When the teams decided that FOSS was the best curriculum to promote this process, they applied to and became part of the statewide FOSS Leadership Academy (FLA) supported collaboratively by the FOSS project at the Lawrence Hall of Science, University of California, Berkeley; the WestEd K–12 Alliance; and Delta Education. This project developed a team of site and district leaders to design FOSS module trainings (incorporating science notebook techniques, formative assessment tools and strategies, and English as a second language methods into the FOSS lessons) as integral parts of the professional development plan.

The in-depth, three-year professional development program provided classroom and leadership knowledge and skills for the Montebello leadership team, through workshops and on-site technical support. The team consists of a district science representative, Arturo Navar; site principal, James Sams; and teachers, Araceli Caldera,
in this school with a fairly stable population, the real picture is revealed by looking diagonally down the chart at the data that represents the performance of a stable cohort of students. The students who were in second grade in 2006–07 had 2% at advanced/early advanced CELDT. The next year (2007–08), those same students were third graders and 7% were at the target. As fourth graders in 2008–09, 31% were at advanced/early advanced! And it’s even better for students who began as second graders in 2007–08 after the teachers had a year to hone their skills: 1% to 25% to 41% advanced/early advanced by fourth grade.

Parents have also developed a strong commitment to the school and the program as a result of parenting classes and an extensive volunteer program. With large classes and limited funds, materials are always a challenge. FOSS kits are designed for classes of 32 students, so the leadership team decided to organize a science room with all the serviceable materials from past science programs that could be used to augment the FOSS kits. On one Saturday, with a small army of parents organized by Jo Topps and the FLA leadership team, a room piled high with old science materials was reorganized, with all materials in clear plastic bins and labels describing what and how many items each bin contained.

Teachers began immediately to use the materials, enabling even more students to have direct hands-on experiences! Maggie Ostler, Delta Representative for the school, also spent that Saturday helping inventory old FOSS kits and ordering supplemental materials to update them to the current version of the modules. This time was all volunteered because a diverse group of people had a synergistic vision of how to make things better for their students, children, teachers, and clients.

**Making Connections continued**

Leslie Hiatt, and Ricardo Ramirez. Team members lead the FOSS professional development sessions and support the rest of the staff in developing strong FOSS classroom practices integrating language acquisition skills. Mr. Sams noted that children are excited about their science experiences. He overheard them discussing what they had learned, using precise academic language, when he was walking around the playground during recess.

At a regional meeting of the FLA, Mr. Navar shared CELDT performance data for students at Bell Gardens over four years (the length of time the program has been in place).

The data were charted for second, third, and fourth graders for four consecutive school years. Looking across the chart, increases are significant. But...
tremendous progress toward closing the achievement gap.

In Rachel Braddell’s third-grade class, students are learning about seeds. After students learned that the part of a plant that produces seeds is the fruit, they cut open a diverse collection of fruits and vegetables, discovered, counted, organized, and graphed the seeds, and discussed the experience of analyzing fruits and vegetables. Students organized their seeds in a variety of ways, counting and numbering them on paper plates prior to recording on the data charts in their science notebooks. Ms. Braddell moved from group to group, questioning, discussing, and listening to be sure the scientific procedures and concepts were accurate, that all students were included, and that they were using academic language in their discussions and writing. The room pulsed with the energy of discovery and sharing. Every student was actively engaged. On the same day, volunteers were digging holes so students could plant shrubs donated for a butterfly garden in front of the school. Several classes were monitoring plants and animals on the public land near their school where they partner with government employees to record data from their study plots. At the end of the lesson in Ms. Braddell’s class, students had to be gently persuaded to abandon their studies to go to recess after setting their seeds aside to dry.

Amazingly, EARTHS is one of the Title 1 schools in the district, but these children are achieving at or above their peers who lead more affluent lives. According to EARTHS principal Jennifer Boone, their work through the years of participation in the FOSS Leadership Academy, which coincided with the opening of the school, is closing the achievement gap between low and high socioeconomic populations in Conejo. Their FOSS leadership team has led FOSS module trainings, facilitated grade level and other meetings, organized field experiences along with their colleagues, written grants, worked with parents and community members, and, in many other ways, helped EARTHS become an exemplary science-centered school. Hats off to these EARTHS FOSS leadership team members: principal, Jennifer Boone, and teachers Alicia Gross, Sue Lewis, Cathy Lewis, Kathryn Peoples, Yoli Fitzgerald, Laura Pewe, Jessica Moore, and Christine Steigleman.

The above chart shows the science performance data of students at EARTHS and in the district as a whole who are proficient or above on the California Science Test (CST). In one year, in all cultural categories, EARTHS students not only closed the achievement gap, they turned it around and moved ahead of the district as a whole in science. In English language arts (ELA) and math, they are the only Title 1 school in the district with scores above or near the district average. Based on the results of the CST on which
Developing Tier 2 and 3 Vocabulary at Mitchell Elementary, Charleston, SC

By Ellen Mintz, FOSS Consultant, and Brian Campbell, FOSS Staff Developer, The Lawrence Hall of Science

The teachers at Julian Mitchell Math and Science Elementary School strongly believe in the need to build students’ vocabulary knowledge in order to improve academic achievement. Mitchell Elementary is a pre-K–6 Title One school in Charleston, South Carolina. Mitchell is also a partial math and science magnet school, which means students can apply to come to Mitchell from other areas of the district. Mitchell is situated in a high poverty area of Charleston. Although poverty does not always mean a student has limited life experiences, it is the case for most of the neighborhood students at Mitchell. The teachers recognize this reality and go to great lengths to provide a high quality, active program for students in an effort to mitigate some of the experience gaps the students have. The barriers faced are not unlike the ones teachers of ELL students face on a day-to-day basis because of the limited language proficiency the students possess. The research suggesting that high poverty students have a more limited vocabulary than their classmates from middle and high-income areas is confirmed in the Mitchell student population.

Teachers want students to command more vocabulary. To really know a word means several things.

1. The student can pronounce the word and recognizes word parts such as prefixes, suffixes, and base words.
2. The student knows that a particular word may have multiple meanings.
3. The student knows when to use a word when speaking or writing.
4. The student can explain the meaning of a word to someone else.

Bringing Words to Life by Beck, McKeown, and Kucan (2002) introduces three tiers of vocabulary words based on the frequency of use and complexity of meaning. Tier 1 words largely consist of high frequency, sight words, and basic words that students encounter in their everyday lives. They usually don’t have multiple meanings and can be easily demonstrated or pointed out. Examples would be boy, girl, walk, turn, and again.

Tier 2 words are more complex and abstract. They are words or concepts that students must understand in order to tackle more technical vocabulary subject-related words. Examples would be names of tools used in investigations or actions students take while investigating (e.g., syringe, balance, property, measure, record). These words also allow students to be more descriptive and precise in their communication and are often multiple-meaning words. Teachers use Tier 2 words during direct instruction and questioning.

Tier 3 words are low-frequency/content specific words. These words are most often introduced as a need arises. Saturation, carapace, variable, and electromagnetism are examples of Tier 3 words that students learn and are expected to use in science. FOSS refers to these words as science vocabulary words in the FOSS Third Edition Science-Centered Language Development chapter.

The FOSS curriculum provides opportunities for students to use Tier 2 and 3 vocabularies as students engage in active investigation. Students have conversations with each other about their thinking, write about their investigations, and read articles to enhance their understanding. Teachers question students as they are engaged in an activity or when they hear students talking to each other about an activity. Teachers also have written evidence about vocabulary usage when students are asked to explain their thinking when answering focus questions or reflecting on what they have learned.

Teachers at Mitchell Elementary experienced problems assessing student understanding of the concepts they are teaching and finding clear evidence of learning. It was difficult to determine whether students were having trouble understanding a concept or if they were having trouble communicating that understanding due to their difficulty with Tier 2 and 3 vocabulary words. Teachers noticed students were able to articulate the concept, but could not attach the correct academic (Tier 3) term to it. Because of this, the teachers at Mitchell Elementary needed to engage students specifically in the development of Tier 2 and 3 vocabulary words. By implementing several strategies shared in the Science-Centered Language Development chapter and some of their own, the teachers began to address the needs of their students.

Prior to starting a new FOSS module, teachers would frontload (direct teaching) key words used to describe the materials used in a kit. Students would interact with syringes, rubber stoppers, and funnel stands and engage in conversations discussing the materials and how they might be used. Some teachers would use the equipment photo cards found on FOSSweb to serve as visual reminders of the Tier 2 vocabulary associated with the materials.

Teacher-direct instruction or a class science notebook were the vehicles for introducing and recording new vocabulary. Teachers were then able to model the use of Tier 2 and 3 vocabulary when it came up in the context of the active investigation, sometimes using sentence frames to scaffold student writing in order to reinforce student
understanding of the new vocabulary. This was especially powerful at the beginning of the year in the primary grades where a class notebook was the main tool used for introducing new vocabulary needed to engage in meaningful class discussions.

The work sample pictured here shows how early learners used the class notebooks as a reference tool for creating their own notebook entries. At the beginning of the lesson, the focus question was introduced. Even though many students could not read the question on their own, it served as an important tool for reviewing letter sounds and word elements. During a whole class discussion following an investigation, students recalled important facts and words, and the class created an entry for the class notebook. Students used this entry to guide their own entries, choosing words and concepts to use, but making their notebook entries different from the class entry.

As scientific concepts were built and introduced, the new words were added to a content area vocabulary wall. These Tier 2 and 3 words were first written on cards before being affixed to the wall. Students could move and group these words in different ways based on the concept being taught and discussed.

When students were preparing to answer a focus question, discuss an investigation, or reflect in their science notebooks, teachers asked students what specific words should be used in their responses. As students suggested a word, the class would discuss its meaning and share how it is connected to the concept. Students would also tell why that specific word should be included in the response. The words were then physically placed together on the wall to reflect the discussion that was held. Teachers found this particularly important when students were learning to write complete and concise responses. An example of a conversation might be as follows.

Focus question: Where does the solid material go when a solution is made?
Teacher: What words do you think should be included in your response to make it as complete as possible?
Student: I think dissolve would be a good word to use.
Teacher: Why do you think so?
Student: Because when a solution is made the salt dissolves?
Teacher: Can you make a solution with other solids? Will other solids dissolve in a solution or just salt?
Student: Other things will dissolve. Sugar will dissolve in water, too, and make a solution.
Teacher: OK. Does everyone agree dissolve would be a good word to include? (The word card for dissolve is moved to front board.) What’s another word you might want to include?
Student: How about solute?
Teacher: What does solute mean? Why should we use solute in our answer?
Student: The solute is the solid part of the solution. It’s what dissolves and that’s what the question is about.

These science vocabulary conversations continued until the needed vocabulary connected to the focus question had been reviewed. The relevant Tier 2 and 3 words were visible and accessible for students to use as they wrote their responses to the focus question. As students progressed, the teachers gradually released the responsibility of selecting important words to the students.

In kindergarten classes, teachers modeled and provided opportunities for students to discuss and draw the Tier 2 and 3 words before they were able to respond in writing. These entries are usually just illustrations at the beginning of the year, but become more sophisticated as students’ language skills progress.

Regardless of the strategy used, the target remains unchanged. The teachers at Mitchell Elementary recognized the need to support their students’ expanding vocabulary and the direct impact that expanding vocabulary has on student achievement. The FOSS program provides opportunities for developing vocabulary and for increasing the literacy skills without sacrificing its primary goal of building and understanding of the world around us.

Reference
It's not news that teachers need more time to teach quality science. That includes time for active investigation and discussions, reading, writing in science notebooks, and the critical reflection necessary for thorough development of science concepts and practices. Language supports the teaching and learning of science in many ways. Speaking, listening, reading, and writing are the key domains of language. Language supports science learning as partners share observations of isopods in a runway, record their observations in their science notebooks, read an article, or discuss their ideas about what might happen next.

With the universal emphasis on literacy, some districts are asking teachers to use language boards. A language board is a set of questions and prompts (maybe 3–10) displayed on a piece of poster board that teachers use for engaging students in oral or written review of language concepts. Prompts may direct students to put words in alphabetical order or to punctuate a sentence correctly. The questions can be answered aloud by students in groups as responses recorded in notebooks for a more individualized exercise. Every day the questions are changed to reflect the different language skills being taught and that should be reviewed and practiced.

Seeing an opportunity for more science, the FOSS Leadership Academy team at Clifford School in Redwood City, California, started supplementing the daily boards with science content specific to the FOSS module they were using. For a third grader working on the FOSS Structures of Life Module, a prompt to identify the prefix, suffix, root word, and definition would display the words organism and predict. Or students would be asked to find the proper and common nouns in a sentence, such as Barbara McClintock’s family and home are in Hartford, Connecticut, based on a reading in the FOSS Science Resources book. Kindergarteners using the FOSS Animals Two by Two Module would respond to prompts about words, letters, and sentences.

The goal is to develop one science board for each investigation in every module at each grade level. FOSS Academy Leaders have found the new science language boards very useful for reviewing vocabulary and key concepts introduced in the investigations. They give a meaningful context for reviewing language structures, while providing that extra time to review and discuss science concepts. In addition, responses to prompts can be expanded into stories, poems, plays, and drawings that serve as derivative student work with a focus on science . . . all done during language arts time while double-dipping to capture a little more time for science!

Leaders at Clifford School also view the science language boards as helpful tools to encourage other teachers to do more science and still address language skills. Teachers are encouraged by students’ progress and enthusiasm. Science language boards may seem a small way to support science, but the boards can be an effective way to give teachers and students a gateway to more science in the classroom.
Every place I turn, I hear persistent murmurings and occasional pronouncements of the urgency of STEM (science, technology, engineering, and math) education. The rhetoric claims that STEM education is critical to the success of the economic future of the United States. The captains of industry have raised an almost unanimous voice calling for a generation of career and college-ready K–12 STEM literate graduates to enter the workforce of industries and play leadership roles in science, technology, and engineering innovation as the 21st century advances. The message is being exercised in the media whirlwind and a few outposts of exploratory education programming, but there is little evidence that the message has risen to a level where it is being heard in the halls of K–8 educational policy. U.S. elementary education policy remains doggedly committed to a driving policy focused on grade-level reading skills. Granted, the ability to engage in complex language interactions is critically important, but so, too, is the ability to engage in discourse about ideas, particularly those associated with the structure, organization, and operation of natural and engineered systems.

In the 2011 National Research Council’s report on the status and future of STEM education, the NRC committee lodges its first recommendation to state and national policy makers.

To make progress in improving STEM education for all students, policy makers at the national, state, and local levels should elevate science to the same level of importance as reading and mathematics. Science should be assessed with the same frequency as mathematics and literacy, using a system of assessment that supports learning and understanding. Such a system is not currently available. Therefore, states and national organizations should develop effective systems of assessment that are aligned with the next generation of science standards and that emphasize science practices rather than mere factual recall.

Why have K–8 educators failed to accept the challenge of STEM education? I perceive several factors conspiring to keep STEM education suppressed. First, educators at all levels don’t understand what STEM education is, nor yet fully appreciate the importance of STEM literacy. STEM is an acronym, standing for four distinct disciplinary areas—science, technology, engineering, and mathematics. STEM education is not, however, simply coordinating a curriculum in which students study the separate disciplines either sequentially or concurrently. STEM has been described as a metadiscipline, rather more like a separate discipline, a discipline that is a coherent blending of several sources of traditional disciplinary skills and intelligences to produce a unique flavor in which the elements of the contributing sources are still detectable, but fused into a new whole. STEM is a way of thinking, a comprehensive understanding of contemporary technological society, and the complex integration of the scientific, engineering, and technological dimensions of the issues defining the new American dream.

Second, too few educators appreciate the consequences of neglecting STEM education. If the futurists are correct, three in five rewarding, stimulating jobs available to the elementary students in our schools today will be STEM-related. And understanding many of the most pressing societal issues facing those same students when they become voting citizens in a few years will require STEM-related knowledge. Responsibility rests on the shoulders of the faceless policy makers who have failed to prioritize STEM education.

The starting time and place for STEM education is in the elementary school. Kindergarten is about right. STEM starts with S, and not incidentally, an academic STEM education starts with science education in the early years and grows in complexity and diversity as students advance through their school careers. But, of course, doing anything effectively requires spending time on the subject. The NRC STEM education report

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The Specter of STEM continued

makes these summary recommendations in its “What schools and districts can do to support effective STEM education” section.

- Districts should devote adequate instructional time and resources to science in grades K–5. A quality science program in the elementary grades is an important foundation that can stimulate students’ interest in taking more science courses in middle school and high school and, possibly, in pursuing STEM disciplines and careers.

- Districts should ensure that their STEM curricula are focused on the most important topics in each discipline, are rigorous, and are articulated as a sequence of topics and performances.

- To improve teaching and learning in the STEM disciplines, districts need to enhance the capacity of K–12 teachers. STEM teachers should have a deep knowledge of their subject matter and “an understanding of how students’ learning develops in that field, the kinds of misconceptions students may develop, and strategies for addressing students’ evolving needs.”

- Districts should provide instructional leaders with professional development that helps them to create the school conditions that appear to support student achievement. School leaders should be held accountable for creating school contexts that are conducive to learning in STEM.

With a national trend of steady reduction of time devoted to elementary science, it seems unlikely that there will be a significant change of policy soon. A number of systems around the country are exploring strategies for acquiring more time to teach science. Most of the time-acquisition models involve extending the instructional day, rather than establishing new priorities. Extending the instructional day is fraught with difficulties, including legally defined instructional day lengths, union contracts, and community resistance. Where the extended day is designed to accommodate the most disadvantaged students, issues of equity emerge.

Extended day is unlikely to be the most acceptable way to solve core issues in elementary science education. Models based on restructuring the academic curriculum hold a lot more promise for STEM reform. A model of curriculum reform that promotes a more fully integrated education holds promise. A science-centered curriculum provides plenty of time for thoughtful, productive science education while enhancing language arts and mathematics achievement, which, incidentally is in agreement with the Common Core State Standards for English Language Arts and Literacy in History, Social Studies, Science and Technical Subjects. Implementing a science-centered educational philosophy will require significant overhaul of the current vision of U.S. schooling and learning, realizing the revised vision will require a new commitment to professional development of teachers and administrators, an investment in appropriate instructional materials, and a concerted community education program. A science program in which students learn and exercise their language arts and math skills in the context of grappling with principles that define and govern the operation of the natural world and apply their new understanding to solve problems and meet challenges in the designed world is living the STEM vision.

The NRC STEM education report also cites findings that relate to student STEM learning more generally.

The elementary schools that improved student learning in mathematics and reading shared five common elements:

1. School leadership as the driver for change. Principals must be strategic, focused on instruction, and inclusive of others in the leadership work.

2. Professional capacity or the quality of the faculty and staff recruited to the school, their base beliefs and values about change, the quality of ongoing professional development, and the capacity of a staff to work together.

3. Parent-community ties that involve active outreach to make school a welcoming place for parents, engage them in supporting their children’s academic success, and strengthen connections to other local institutions.

4. Student-centered learning climate. Such a climate is safe, welcoming, stimulating, and nurturing environment focused on learning for all students.

5. Instructional guidance that is focused on the organization of the curriculum, the nature of academic demand or challenges it poses, and the tools teachers have to advance learning (such as instructional materials).

We’ve heard it enough now to know how to talk the STEM talk. It is now time to resolve to walk the STEM walk.

Additional reading:


National Park Service Expanding Reach Into STEM Nora Fleming http://www.edweek.org/ew/articles/2011/12/14/14parks.h31.html?tkn=NOOFDbOxmnIl9isr7cArLBWpgl2F7HvAbn3&intc=es
Life As We Knew It
By Susan Beth Pfeffer

Reviewed by Jessica Penchos, FOSS Staff Developer, The Lawrence Hall of Science

This book, discovered by a staff member's teenage daughter, has been sweeping through the FOSS staff, being passed from colleague to colleague as a must-read. The premise is stated upfront on the book jacket—a meteor strikes the Moon, impelling it closer to Earth. The intrigue of the book lies in the careful unfolding of the sequence of events that results.

The book is written as the journal of 16-year-old Miranda, an average student with a passion for ice skating. Her world revolves around friends, romantic interests, and parental expectations, until the night of the impact. Scientists predicted the meteor's impact, and people around the world gather to view it. What was not predicted, however, was the fact that the meteor could alter the orbital radius of the Moon, pushing it visibly closer to Earth.

People are scared, but they're not sure what to make of it. They turn to news online and on television, but service is almost immediately disrupted. The broken chain of communication leaves everyone, including Miranda and the reader, experiencing a sudden sense of isolation. With cell phone service dwindling and electricity flickering, the world becomes a drastically different place.

Miranda gets only bits of information about what is happening to the world around her, and her family is forced to make critical decisions with limited understanding of what is to come. The closer Moon ultimately results in increased tidal forces on Earth, resulting in massive tsunamis and alterations to geologic activity, including increased volcanic activity that spews ash into the atmosphere. With fuel supplies disrupted, food becomes scarce, and the Sun soon becomes blocked by thick volcanic ash, dropping temperatures across the globe.

The struggle for survival without reliable information about what has happened or what might lie ahead is well-crafted by the author. The changes in Miranda's journal entries illustrate a shift in thinking, as her adolescent concerns are replaced by the emotional strain of worrying whether her family will survive this, as well as a documentation of their physical hardship. Issues of societal collapse and lawlessness are touched upon, and the choices Miranda and her family have to make are sometimes painful.

Once you pick up this book, it is hard to put down. It's a quick and engaging read for students from upper elementary through high school, as well as for adults. There are clear connections with FOSS Middle School Courses, specifically Planetary Science, Earth History, and Populations and Ecosystems. It will lead to fascinating classroom discussions about the effects of the Moon's gravity on tides, the relationship between volcanic activity and atmospheric quality, and the challenges that a population faces under extreme environmental changes. This book will help readers consider our vulnerability as human beings on a small planet and the idea that Earth's seemingly stable systems can change. The topic can be frightening, but the book ultimately portrays the positivity of human spirit and the will to survive in the face of extreme challenges.
FOSSweb 2.0: What’s in it for me?
The new FOSSweb is here! Have you registered yet? If not, you may be wondering about the benefits of doing so.

Some of the new features include
- Resources for each module available on a single page
- Class notes and assignments
- Easy access to eBooks and eGuides

A new feature for our elementary modules is Resources by Investigation, which provides an easy way for teachers to access all the digital resources for each investigation part in a module. It lists links to the teacher masters, notebook masters, assessment masters, and focus questions by part. It also links to any online activities, tutorials, virtual investigations, streaming video clips, and interactive whiteboard resources (if applicable) for each part.

The Resources by Investigation feature will be familiar to middle school teachers who have been able to access Resources by Investigation in the interactive Media Guide; however, it will now be available in a more convenient location accessible directly from the course page.

So if you haven’t yet, please go to FOSSweb.com to register for FOSSweb 2.0. FOSSweb 1.0 will be active until August 2012, at which time all users must be registered on the new site.

Can I use my new tablet with FOSSweb?
Every day schools are purchasing mobile devices such as tablets and other handheld devices for students to use in the classroom. Tablets are an exciting new learning tool, and the FOSS staff sees endless possibilities for tablets to support and enhance the curriculum.

Unfortunately, one of the most popular tablets, the iPad, does not support Adobe® Flash® Player. Flash is a development tool that we have used to develop many of our multimedia pieces (interactives, simulations, animations, and videos). We feel it is currently the most powerful tool to create interactive media.

We are working to address the access gap for iPad users in several ways.
1. Both FOSSweb 1.0 and 2.0 allow users to easily navigate to find module resources without the use of Flash applications. (FOSSweb 1.0 previously required Flash for some of the navigation pages.) Teachers can easily find notebook and teacher masters, assessment masters, teacher preparation videos, focus questions, and module summaries as PDFs. In addition, our audio stories for the elementary student books are easier than ever to use, particularly on iPads.

2. For our multimedia assets that use Flash, we are looking into a way to package our Flash activities into an app that will be downloadable from the App Store so that users can run them from their iPad. Android tablet users are currently able to use all Flash multimedia.

3. Moving forward, we are looking at other technologies to develop new multimedia that are compatible with iOS. Before beginning development of any new multimedia asset, we carefully weigh the options and pick the best medium. Look for new assets built using HTML 5 and other technologies soon.

Please know that we are working toward an enjoyable and educational user experience for all our users. Watch this space for updates on our mobile app content.

We want to hear from you!
Please send us your feedback! We want to hear from you—both the good and the bad—about FOSSweb! Send an email to support@fossweb.com or call our support line at 510.643.6997.

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 the Lawrence Hall of Science 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
The Lawrence Hall of Science
University of California
Berkeley, CA 94720-5200

The deadline for submissions to the next issue is June 8, 2012. We’re waiting to hear from you.
FOSS Institutes

Delta Education will host two one-day FOSS Institutes before each of the three regional NSTA Conferences in Louisville, Kentucky (10/17); Atlanta, Georgia (10/31); and Phoenix, Arizona (12/05). 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 Third Edition for K–5 and the new revised Planetary Science Course, 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 an Institute, please write, fax, or e-mail:

Pam Frisoni
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Nashua, NH 03063
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Fax: 920.882.4598

NSTA 2012 NATIONAL CONFERENCE

Indianapolis, IN March 29–30 2011

FOSS K–8 Workshop Schedule

Thursday, March 29, 2012

8:00–10:00 The Next Generation of Active Learning with FOSS Third Edition
10:30–12:00 Using FOSSweb 2.0 and Technology to Support Learning
1:00–3:00 Taking Science Outdoors with FOSS K–6
3:30–5:00 Science-Centered Language Development Using FOSS

Friday March 30, 2012

8:00–10:00 Out of this World! Planetary Science for Middle School
10:30–12:30 Using Science Notebooks to Impact Student Learning with FOSS
2:00–4:00 FOSS Formative Assessment: Making Student Thinking Visible

For more information about these workshops and other professional development opportunities, visit the FOSS Professional Development calendar at http://www.fossweb.com/news/calendar.php.

Summer 2012 Calendar

Middle School Institutes

July 17–20 (Tuesday–Friday)
Planetary Science Institute, Second Edition
Location: The Lawrence Hall of Science, Berkeley, California

July 30–August 3 (Monday–Friday)
Chemical Interactions Institute
Location: Lawrence Berkeley Laboratory, Berkeley, California

For more information about these middle school institutes, contact Jessica Penchos at 510-643-5145 or via e-mail, jpenchos@berkeley.edu.

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
jason.crowell@schoolspecialty.com

Follow us on Facebook and Twitter!

http://www.facebook.com/FOSSscience
http://twitter.com/FOSSscience
See you at the NSTA National Conference in Indianapolis, IN, March 29–April 1, 2012!

Watch for exciting new changes at FOSSweb.com!