A Tale of Two Rivers:
FOSS Arrives in a Large City and a Small School!
By Marilyn Roode Decker and Paul Hickman

In 1996 the Full Option Science System (FOSS) was showcased and offered as one of the exemplary curricula for CESAME’s (Center for the Enhancement of Science and Mathematics Education) Statewide Implementation Program in Massachusetts. We received pre-proposals from four sites from which two were selected for support this school year. One of these, Fall River, is a city of about 90,000 in southeastern Massachusetts on the Taunton River with 30 elementary schools and almost 7,000 students. The other, the Swift River School, is a single preschool through 6th-grade elementary school in north central Massachusetts. It serves the rural towns of Wendell and New Salem with about 230 students.

While it might seem that these two sites have little in common, there are at least two things that unite them. Both have strong teams of teachers, parents, and administrators committed to improving how science is taught and learned. We knew that parents would be skeptical when their children did not come home with elementary schools and almost 7,000 students. The other, the Swift River School, is a single preschool through 6th-grade elementary school in north central Massachusetts. It serves the rural towns of Wendell and New Salem with about 230 students.

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Beyond the Box
By Steve Murray

The Holyoke Public Schools have been using the Full Option Science System for the past four years as our primary science curriculum. When we decided to switch to a hands-on approach to teaching and learning of science, we knew it would be important to find ways to inform parents of the transition and allow them to experience the work their children were doing in the schools. We knew that parents would be skeptical when their children did not come home with

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**Fall River's Story**

Fall River began its hands-on science initiative in 1989 after attending an NSRC Elementary Science Leadership Institute. The school district team put together a program from materials that were available at the time, kits from the Boston Museum of Science, materials from other districts, and teacher-developed materials. They created a district-wide materials center, a resource library, a strong community outreach program, and a cadre of well-trained lead teachers. A review of the curriculum in 1995, however, revealed areas of weakness in the program. Because the greatest need was for physical science materials, Fall River submitted a proposal to CESAME and received a grant to implement the FOSS Physical Science Strand.

Pam Tickle, the Elementary Science Staff Developer, arranged for Sheila Dunston, an experienced FOSS user from New York City to provide initial training sessions. Lead teachers attended the FOSS awareness institute at a regional NSTA meeting and a series of presentations by Dr. Larry Lowery on the Biological Basis of Thinking and Learning; Developing the Case for Hands-on Science; and Asking Effective Questions. These lead teachers will help to shape the ongoing professional development for the 293 teachers involved in FOSS implementation. The project will impact over 6,500 students including a great number who are economically disadvantaged.

**Swift River's Story**

This story started as Swift River School’s Science Frameworks Study Committee was working to eliminate gaps and duplications in the school’s preschool through 6th-grade science units. The committee saw the need for a unifying vision to tie the units together. The school’s principal, Leonard Strauss, attended a CESAME showcase and wondered if adoption of FOSS might appeal to the committee, especially since funding and support were available through SIP.

**Who is CESAME?**

CESAME, established in 1991 at Northeastern University, has gained recognition locally, regionally, and nationally for its efforts in creating awareness for and implementation of standards-based curriculum. CESAME’s Statewide Implementation Program (SIP) seeks to answer the following question: How can a school district achieve sustained implementation of standards-based mathematics and science curricula?

CESAME’s full- and part-time staff represents all levels of the educational community from elementary to higher education, including three Presidential Awardees. Most have expertise as curriculum developers and workshop leaders. All are committed to professional growth and have strong connections to national and local reform efforts. CESAME serves as the curriculum implementation resource for the Massachusetts SSI (PALMS) which has been selected for phase II funding. CESAME also helps to coordinate one of the SSI’s five regional providers, the Metro Region, which contains over 40 districts including the city of Boston.

(Note: See the article, Beyond the Box, on p. 1 of this issue for information about another PALMS-related project.)
(Statewide Implementation Program). Paul Hickman from CESAME brought a representative sample of FOSS materials to a “release time” meeting of the committee for review. Subsequently the committee agreed to apply for SIP funding.

The plan was to implement two new FOSS units at each multi-grade level (Pre–K, 1–2, 3–4, 5–6) the first year with two more units in year two. Different units would be taught every other year. Steve Murray, an experienced FOSS trainer from Holyoke, led the five-day summer professional development. Release time has been provided for teachers to meet and discuss the implementation during the school year. The school’s new principal, Christine Lewis, was able to “hit the ground running.” With a strong team of teacher leaders in place, the FOSS implementation is on schedule in spite of a change in administration. All of the school’s 230 students are doing science, and their teachers are experiencing the advantages of using carefully developed and researched instructional materials.

Six districts from all corners of Massachusetts have submitted proposals to implement FOSS in this year’s SIP funding cycle! Once sites are selected, CESAME will work with FOSS developers and trainers to design a leadership institute for next summer. CESAME is looking forward to a continuing close relationship with the FOSS development team as we work to scale-up our efforts in New England through our pending NSF-funded IMPACT project. 🏠

**WEB Connections**

For more information about Fall River and its schools, check out its website at [http://www.fallriver.mec.edu/schools1.html](http://www.fallriver.mec.edu/schools1.html).

Further information about Swift River schools can be found at [http://www.tiac.net/users/sriver/index.html](http://www.tiac.net/users/sriver/index.html).

CESAME also has a website which is located at [http://www.neu.edu/cesame](http://www.neu.edu/cesame). Information about the Statewide Implementation Program (SIP) can be found at [http://www.neu.edu/cesame/sip.htm](http://www.neu.edu/cesame/sip.htm).

For more information about PALMS, check out [http://www.doe.mass.edu/palms/](http://www.doe.mass.edu/palms/).

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**What is SIP?**

The Statewide Implementation Program (SIP) is a five-year, National Science Foundation-funded project to demonstrate how districts can successfully implement specific standards-based curricula. SIP identifies and showcases exemplary curricula. Through a contractual agreement, SIP provides districts with multi-year funding, technical assistance, professional development guided by curriculum developers, and linkages to statewide reform efforts. SIP also conducts research to determine the most effective model for disseminating such curricula. Throughout, SIP works to make districts accountable by collecting data and continually focusing on achieving a sustained high quality implementation. SIP’s impact has already far exceeded expectations at both district and state levels. The project has showcased 20 curricula and funded implementation of 13 curricula at 39 sites involving over 100 schools, 1,000 teachers, and 25,000 students.

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**What is PALMS?**

PALMS (Partnerships Advancing the Learning of Mathematics and Science) is a cooperative initiative of the Massachusetts Department of Education and the National Science Foundation. PALMS brings school districts together with colleges and universities, adult learning centers, businesses, museums and cultural institutions, parents, students, and community groups. Working together, partners on Leadership Teams develop mathematics and science action plans; support classroom change; provide important resources and expertise; make key decisions; and share information and build public awareness.

PALMS Districts are school districts that have demonstrated commitment to the systemic improvement of mathematics, science, and technology education. Commitment is exemplified by the development and maintenance of an active Leadership Team comprised of district personnel and community partners; the development and implementation of a quality district action plan for mathematics, science, and technology education; and by the development of mathematics, science, and technology teacher leaders.

Marilyn Roode Decker (mdecker@lynx.neu.edu) and Paul Hickman (p.hickman@nunet.neu.edu) work at CESAME, The Center for the Enhancement of Science and Mathematics Education at Northeastern University in Boston.
a textbook. We wanted to give them some background and insights into FOSS. We wanted to emphasize and help parents understand that this new hands-on method would help their sons and daughters develop a better conceptual understanding of the world around them.

We used several methods to inform parents about the FOSS program including broadcasts during the regular school system timeslot on the local cable television station. We also held parents’ nights during which the parents could experience the FOSS program with their children.

The H.B. Lawrence Elementary School’s annual science fair took on new meaning when the FOSS program was introduced to the school. The fair is now a showcase during which students display their understanding of concepts and abilities necessary to use scientific thinking processes learned during their FOSS experience. The students work in pairs on projects which are outgrowths of classroom investigations with FOSS. Students develop their own projects, carry out investigations, and prepare posters and verbal explanations regarding the results of the investigations. Their experiences with the FOSS modules and with working collaboratively help them more effectively present the results of their projects.

The science fair also provides us with another opportunity to evaluate our students as well as demonstrate to their parents and the community the high level of understanding that our children are developing at Lawrence School. The parents and community who attend the science fair see the results of the FOSS program and have responded very favorably. This science program has also been an excellent recruitment device, attracting new students to our school.

We have also made an effort to extend our kits in meaningful ways by developing contests or field trips to supplement the classroom activities. At the end of the Models and Designs Module, we have a Naked Egg Drop contest. Students are given six sheets of 21 x 28-cm (8.5 x 11-inch) copy paper and 100 centimeters of tape. Each group of four is challenged to create a freestanding container that will successfully catch a raw egg without breaking when dropped from a standard height. One of our parents, Frank McGinnis, created a device that allows all the eggs to drop in exactly the same manner.

The only variable the students test is the design of the container they construct. All groups are given the opportunity to redesign their containers after the first try. Groups that were unsuccessful on the first attempt use the knowledge that they gained from that experience and from observing others to create a successful container for the second attempt. Those who were successful try to improve upon their design. The contest provides a fun context for the students to exhibit their understanding of the science principles they have learned.

Through PALMS (Partnership Advancing the Learning of Math and Science) and the Massachusetts Statewide Systemic Change Initiative (SSI), we developed a very successful field trip. The trip takes the science concepts of concentration, solution, and volume developed in the Mixtures and Solutions Module to the chemistry labs at Mt. Holyoke College. Dr. Ed Fitzgerald and Dr. Ed Weaver at Mt. Holyoke College developed an activity in which groups of students work together to make slime. The students are provided polyvinyl alcohol, borate, water, and food coloring as their ingredients for the slime. They are also given some parameters and limits for amounts that they may use of each ingredient. Each group gets three chances to make their perfect version of slime. Students were excited by this activity. One student described the slime as “gooey slime, runny slime or even bouncy slime.” One of the students interviewed for our
cable program said “now I know why we learned what we did in class—all the measuring and being careful is very important.” The teachers and parents also enjoyed the time in the lab helping the students with their creations.

The trip to the lab tied the concepts and principles learned in the classroom to a real-world setting for both teachers and students. It exposed our urban and mostly minority students to the college in a very successful, non-intimidating way. Over 400 fifth-grade students returned to their classes feeling better about themselves and their ability to work cooperatively. The lab coats, goggles, and attention given to them by the college professors and staff gave them a new appreciation of science.

The FOSS kits have become the cornerstone of our curriculum. The extensions we have developed give more meaning to the experiences our students have with FOSS. Field trips, science fairs, and contests give the students opportunities to exhibit their knowledge and their skills to themselves, their peers, and their parents.

Steve Murray is a science resource teacher at H. B. Lawrence Elementary School in Holyoke, MA (smurray@k12.oit.umass.edu).

This go-cart project displayed at the Lawrence School science fair is an extension of the FOSS Models and Designs Module.

Students concoct slime at Mt. Holyoke chemistry lab.
There are many variables that contribute in different ways to the effectiveness of instruction. One variable is seldom examined in detail even though it has a major influence upon learning. That variable is the physical arrangement of learners.

Expert teaching can be distinguished from novice teaching by the strategic use of a variety of classroom arrangements. These include the:

- **Didactic Structure** (e.g., the teacher lectures or demonstrates to the class),
- **Individual, Tutorial** (e.g., student and teacher both active in two-way transmission of information),
- **Individual Task Structure** (e.g., each student reads and answers the questions at the end of the chapter),
- **Cooperative Group Structure** (e.g., students work together on a task), and
- **Collaborative Group Structure** (e.g., students gather data to test their ideas and compare their data and explanations with those of others).

Which arrangement is used depends upon the purpose of the lesson. Many lessons utilize more than one type of arrangement. Placing students in social learning settings is an effective way to stimulate interest, enhance cognitive development, increase self-esteem, and raise achievement (Johnson and Johnson, 1984). Research also shows that such arrangements increase student participation, achievement, and learning (Glatthorn, 1991).

The five classroom arrangements are used strategically and thoughtfully throughout FOSS lessons.

### 1. Whole Group, Didactic

Whole group, didactic instruction is the most common arrangement observed in traditional classrooms. The use of the whole group, didactic arrangement increases dramatically from middle school through high school.

This physical arrangement is set up for the purpose of one-way transmission of information. The students are receivers—passive, observing, listening, or taking notes. The delivery of information takes the form of a lecture, a report to the group, or simply the presentation of a television program or a movie.

The value of whole group, didactic instruction is that it is sometimes efficient to have everyone hear the same thing at the same time. It works well for giving directions, introducing a new topic, demonstrating, reviewing, or entertaining. It is commonly seen in large lecture halls, on field trips, at movie theaters, and in any situation where the students are expected to be receivers of information.

FOSS makes use of this arrangement at the beginning and end of activities. For example, before a field trip in the **Trees Module**, students are given an overview of what is to take place, the goals of the field...
By asking the student to explain her thinking, the teacher learned a great deal! For one thing, the student was not guessing. And the 19 did not result from faulty memory. The thinking was very complex. The student had subtracted one rather than two. The thinking was rich. The student had made a cosmic error, not a structural error.

“Ah, I get it,” says the teacher. “So tell me. What is 9 + 10?”

“That’s 19,” says the student. “Wait a minute. That other thing you gave me, 9 + 9? That has to be 18!”

In this tutorial interaction, the teacher assessed a student’s thinking, realized the nature of the “error,” and provided a critical competitor (10 + 9) for the student to compare with the 9 + 9 problem. This interaction took place in about 40 seconds.

No other teaching arrangement allows for such personal assessment and personal assistance as does the tutorial arrangement. The tutorial arrangement is valuable for assessing, conferencing, coaching, counseling, remediating, and supporting specific skills or information. Using this arrangement allows the teacher to personalize the instruction. Using this arrangement, the teacher can respond more effectively to different learning styles.

3. Individual, Task Orientation

Putting each student to work on a task is the second most common instructional arrangement seen in traditional classrooms. It is used to give assignments that are carried out by students working independently from each other. It is most often used when a teacher assigns lessons in a textbook or workbook—a math lesson, spelling page, or step-by-step experiment. All students might be assigned the same task or be given different tasks. In either case, the arrangement frees the teacher to wander.
from student to student—diagnosing, providing information, or facilitating by interacting with an individual student (thus incorporating a tutorial arrangement within the individual task arrangement).

It is this type of teaching that textbooks promote almost exclusively. If the tasks are well written, they can be performed independently by the students. If the tasks are poorly written, students will struggle, do the work incorrectly, or have many questions which requires the teacher to explain (didactic) parts of the task.

The arrangement can be used effectively with non-text driven activities. For example, when students examine their own fingerprints in the FOSS Ideas and Inventions Module, each student independently focuses on a common task: examining fingerprints. Similarly, when students construct their own Bonita skeletons in the Human Body Module, they work individually on a common hands-on task. During such instruction, the teacher is free to assist, facilitate, and assess as she finds necessary.

4. Small Group, Cooperative

Small group, cooperative arrangements are characterized by subdivisions of the class into groups or committees. Objectives for groups can be assigned, roles in the group can be delineated (e.g., chairperson, recorder, etc.), and standards for harmonious group work can be set. For cooperation to take place, it is important that roles be delineated. While the groups are working, the teacher is free to roam and monitor their progress.

Other than to organize the cooperative setup, no teacher transmission of information, except as requested, is given. The teacher is free to roam among groups to facilitate the progress as needed or to interact with an individual (for tutorial purposes). Examples of this arrangement are used in the setup of many FOSS activities. For an electricity activity in the Magnetism and Electricity Module, a “Getter” gets the materials for his group to use, a “Starter” does the first test with the equipment, a “Recorder” makes sure the data are recorded, and a “Reporter” summarizes findings and reports to the class.

5. Small Group, Collaborative

This instructional arrangement has a subtle difference from the cooperative group arrangement. In this arrangement, teams work on a common task, but each member is equally responsible for the quality of the result. It involves the free and uninhibited discussion by students on aspects of importance to them. In such interactions, students do not play roles, but are equals in the production and assessment of ideas. In the FOSS Models and Designs Module, teams of students are challenged to construct a model of the interior of a sealed black box. Students bring their various prior knowledges to bear equally on the task, comparing and exchanging, testing and debating, assessing and providing evidence for ideas. In this situation, collaboration brings about a resolution or set of possible resolutions to the task better than an individual could in attempting the task alone.

Preliminary research suggests that students improve their language arts skills through this arrangement due to the social relationships within the group. Students explore and communicate with others. They test ideas, hypothesize, evaluate results, record data, keep journals, and write reports. These uses of language enrich the experiences and provide functional uses for talking, listening, reading, and writing (Cohen, 1986). Other research shows that when students work collaboratively, increased reasoning strategies and greater critical thinking competencies result (Johnson and Johnson, 1984).
A Few Additional Comments
The most common instructional “error” some teachers make is to teach didactically when students are in tutorial or small group arrangements. Non-whole group structures open the possibility for other types of effective instruction, but teachers must know other ways to teach to use these arrangements effectively.

Researcher Paul Ammon (1993) found that the whole class, didactic arrangement is favored by beginning teachers and experienced teachers who do not develop expertise in a variety of ways to teach. Even when teachers let students explore materials in a hands-on activity, such teachers tend to summarize for the students what they should have learned (Hutcheson and Lowery, 1988). These teachers believe that students will learn as long as the teacher simply shows or tells them what they need to know (Hutcheson and Ammon, 1987).

One reason why some research shows that a reduction in class size does not make a difference in student learning is the fact that many teachers teach fewer children in the same way they teach many (usually in a whole group, didactic manner). Research that examines the reduction of class size when teachers use non-whole group arrangements with appropriate instructional skill, consistently shows positive, significant gains in learning.

Expert teaching is flexible. Expert teachers have a range of instructional repertoire and know when to use each type. They know that some classroom arrangements achieve better results than others for certain students, at certain grade levels, and for certain instructional goals. Expert teachers are thoughtful about classroom arrangements and the appropriate mode of instruction to accompany them. Through the thoughtful orchestration of a variety of classroom settings as suggested in the activities, FOSS is a vehicle that nurtures expert teaching.

References


Using Museums in Earth Science Teaching: A Cooperative Effort Between Schools and Museums
By Merethe Frøyland
University of Oslo
Museenes skoletjeneste
De naturhistoriske museer

(Editor’s Note: I [Sue Jagoda] met Merethe Frøyland this past July at the Second International GeoSciEd II conference in Hilo, Hawaii. Merethe introduced herself after she heard my introduction to a poster session I was doing on FOSS Earth Science. She was thrilled to meet someone who had been involved in the development of FOSS K–6. I was equally excited to meet someone who was using FOSS in another country. Merethe met Dr. Larry Lowery during a visit he made to Norway several years ago. During the visit, he presented the FOSS program to a group of Norwegian educators. Merethe became familiar with the FOSS philosophy, the scientific thinking processes, and the methods employed in FOSS activities. As part of Merethe’s doctoral project at the University of Oslo, she is working cooperatively with The Norwegian Mining Museum in the development of an education program for elementary school students called GEOMUSA. She decided to use the FOSS Earth Materials Module as part of this program. The following article is an abridged version of her report.)

Background
Norwegian Museums are traditional museums characterized by few interactive exhibits and large numbers of objects guarded by “Don’t Touch” signs. Museum visitor studies show that this type of exhibition is not ideal for promoting visitor learning (Crane, et al., 1994). However, traditional museums have the potential to function as “extended classrooms,” making important contributions to learning for visiting school groups.

The Norwegian Mining Museum is a traditional museum located close to the famous silver mines in Kongsberg. As a visitor you walk around and look at the exhibits, but you are not allowed to touch or manipulate them. The only sense you employ is your eyesight. The museum has different exhibitions of Norwegian minerals, silver from the silver mines, and mining history. As an extension to your museum visit, you can visit the nearby silver mines.

The Norwegian Mining Museum and GEOMUSA
GEOMUSA is a teaching program for students in elementary school, developed in cooperation with the Norwegian Mining Museum. It uses the mineral exhibition, silver exhibition, and the mines. The subject for GEOMUSA is minerals and their properties and the history of silver mining.

The museum’s mineral exhibition displays the beauty and variety of Norwegian minerals. For example, the different colours of quartz and the different crystal shapes of calcite are on display. The exhibition may teach students about the multitude of common minerals and give them an appreciation for the beauty of minerals.

To best appreciate this exhibition, it is important that students have basic knowledge of mineral characteristics. They need to know what a mineral is and that minerals have different properties. To prepare the students for the museum visit we chose an American teaching program called Earth Materials. This is a module from the Full Option Science System (FOSS). FOSS springs from the philosophy of the Lawrence Hall of Science, a philosophy that has guided much of science curriculum development for more than 30 years.

The students enjoy their experiences with the Earth Materials Module. It gives them some basic knowledge in earth science. Upon completion of the module, the students are ready for a more in-depth experience with the rocks and minerals native to Norway as displayed at the museum.

One of the goals of the GEOMUSA program is to have the students become skilled at identifying rocks in the field. Rocks are very diverse. Students need multiple experiences with different minerals and rocks to be able to identify them in the field on their own. A traditional museum of earth science has both collections and exhibitions displaying a multitude of rocks and minerals, extending the classroom experience. They also have museum staff and geologists who usually know of nearby locations where students can observe and sometimes collect rocks and minerals.

GEOMUSA uses the teaching potential of the museum. If students use Earth Materials in school to gain basic knowledge in earth science and then encounter GEOMUSA in the museum to learn and experience the diversity of minerals, they will be prepared for using their knowledge in the field. What is important here is that students can use this knowledge in their daily lives outside school. Combining GEOMUSA with the Earth Materials experience makes the museum visit an extended classroom experience for the students.

Earth Science in Norway
In the Norwegian curriculum for elementary schools, rocks, minerals and their properties are topics for 5th grade. Thus, Earth Materials and GEOMUSA together are particularly well suited for 5th graders. GEOMUSA uses the same educational
Pedagogy as FOSS and is based on the knowledge students have attained in the Earth Materials Module. Earth Materials teaches students the difference between minerals and rocks and how to use acid for identifying calcite and hardness for identifying quartz, calcite, gypsum, and fluorite. In GEOMUSA they learn more about mineral properties and techniques for identifying minerals, such as colour, crystal shapes, cleavage, and lustre. The idea of GEOMUSA is to extend students’ experience in earth science and hopefully make them more able to identify minerals in the field.

The Museum as an Extended Classroom
To function as an extended classroom, museums need to have a program that fits the national curriculum, built on what students are doing in the classroom. This is what GEOMUSA is designed to do.

GEOMUSA has two steps, a museum segment and a mine segment. In the museum segment of GEOMUSA, students are encouraged to explore and identify the properties of minerals. They also learn new techniques for identifying minerals. In the mine segment, GEOMUSA encourages students to use in the field what they have learned in Earth Materials and the museum segment of GEOMUSA. Students also learn how people in earlier times have used this knowledge to find silver in the Kongsberg area. Students do all these activities in two days, one day at the museum and one day in the mines.

At the Museum
In the mineral exhibition of the museum, a collection of minerals is made available for the students to touch, look at, examine, and break apart. We call this “the public collection.” We have put some tables and chairs in the mineral exhibition room at which the students work. We want them to experience the museum atmosphere, totally different from the atmosphere in their classroom.

As in the Earth Materials Module, each student in GEOMUSA is given a notebook for writing observations and conclusions. Students work in groups of four. Each group member contributes to the data collection, data analysis, and reports of results. The museum segment of GEOMUSA has four activities. These activities introduce students to other mineral properties including crystal shape, lustre, and colour. In GEOMUSA, students learn how to conduct tests of these properties to identify a mineral.

The Mine Segment
The mine segment includes two activities.
• Firesetting: Earth science is combined with cultural history to show students that earth science is a segment of our history and our daily life.
• Going for silver: Students are given some practice in using their earth science knowledge in the field.

Firesetting
Students are introduced to the silver mine history from the 15th century when the miners were using firesetting instead of dynamite. Museum staff prepare the mine for firesetting the day before, so when the students arrive the rock inside the mine is loose.

Under supervision, students use hammers and chisels to break loose rock from the walls inside the mine. Other students pick up the rocks from the ground and carry them outside. When the mine is cleaned, students carry wood inside, put it up against the wall, and start a new fire. After a while the mine is filled up with smoke. Suddenly you can hear the rock starting to crack and small pieces of rock falling down. After a few hours the fire has burned down, and the mine is ready for breaking

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Museums in Earth Science continued

down the loose rock again. This method, called firesetting, was used until 1890 when it was forbidden by law (due to its negative effect on the miners’ health).

Going for Silver
After lunch the students are taken to another silver mine to look for silver. The silver usually occurs in calcite veins together with fluorite, quartz, and pyrite. The students have learned about all these minerals and their properties both in the Earth Materials Module and in the museum segment of GEOMUSA.

Students work in groups of five. Each group member looks for one property. One student uses acid to identify calcite, one uses a hammer to look for cleavage, one uses a knife to test hardness, another looks for colour, and another for lustre. We want them to use all they have learned in the Earth Materials Module and GEOMUSA to give them some practice in a “real” field setting. At the same time they experience what miners were doing when searching for silver in the old times.

Research and Conclusions
As part of the research project, pre- and post-tests were conducted to help assess student learning in the GEOMUSA project. The test was given to 200 Norwegian students in grades 3–7, half of whom had gone through both the Earth Materials Module and the museum program. It was also administered to 18 students from the University of Oslo who had been studying earth science for at least 1.5 years. The test was designed to particularly assess the language acquired and used by students and their ability to use what they learned in a field experience. The following are some observations and conclusions from the study.

• Most of the students used several concepts they had learned both in Earth Materials and GEOMUSA to describe rock and mineral samples.

• No students from the university did the test as well as the best students in the 5th grade!

• It seems to be hard for some students to understand that rocks are made of minerals. Some students seem to think that rocks are similar to a box in which you can find minerals inside. They write that there are minerals within rocks. This could be a language problem in Norwegian.

• It seems to be difficult for most of the students to understand that, because rocks are made of several minerals with different properties, a rock has several properties. They describe the granite sample with only one hardness, only one lustre, and so on. However, they usually describe the granite with different colours and use this to conclude that the granite is made of several minerals.

• Students were able to explain more about what they knew about the rock and mineral samples during an interview session.

• Several basic concepts in earth science, like the definitions of a mineral and a rock, are not understood completely by the students. Even the university students had trouble.

• The teachers told me that this was a new teaching method for them, but they loved it and they wanted to use this in other subject.

• The students asked the teachers to do similar projects like the “stone project.”

• One teacher wrote after the second test: “I (would) like to express my enthusiasm by citing one of my most tough and negative pupils...‘thank you for what you have (taught) me.’ ”

The tests show that the elementary grade students have learned a lot from going through this teaching project when compared with the university students who were tested. Moreover, the findings indicate that the Earth Materials Module
Module together with GEOMUSA gives students the experience they need in order to apply their knowledge of rocks and minerals in the field.

Literature

To get further information about Merethe Frøyland’s work with GEOMUSA you can reach her at the Norwegian Museum Authority, Ullevålsveien 11, N-0165 Oslo, NORWAY. Tel: +47 22 11 00 50. Fax: +47 22 11 00 74, e-mail: merethef@romususa.no.

FOSS Middle School Is Out of This World

How did people know that the Earth was round before humans went into space and looked back at this planet? If the Earth did not rotate, what would we have for day and night? Does the moon have day and night? If so, how does it relate to day and night on Earth? What are the theories on the origin of the moon? What did we learn about the Earth and moon by sending probes and humans to the moon? These are some of the questions FOSS middle school students grapple with in the FOSS Planetary Science mini-course currently in national trials in 20 sites around the country.

Planetary Science is the first of nine mini-courses to be developed by the FOSS team at the Lawrence Hall of Science. The course has 11 activities that take 9–12 weeks in a typical middle school setting. And what is a typical middle school setting? It could be a group of 27–35 students who meet with an instructor every day for a science period of 42–55 minutes. Or it could be a group of students who meet three times a week for 90-minute sessions. Or it could be a group of students who meet with a team of instructors, both math and science, each day. The setting could be a laboratory setting or a classroom setting with desks and chairs. There could be one computer in the classroom primarily under the control of the instructor or there could be up to eight computers in the classroom with Internet connections.

The FOSS mini-courses are designed to fit into any of these time and space settings. And, like the FOSS K–6 program, the goal is to make the program an effective and efficient tool for all middle-school science teachers from novice to expert.

The Planetary Science mini-course has four basic components:

- a comprehensive teacher’s guide with background material, equipment descriptions, detailed preparation explanations, the lesson, integration of FOSS multimedia, extension suggestions, homework, and assessments (including a section entitled “Why Do I Have to Learn This?” which addresses students’ attitudes and concerns),
- a Planetary Resources Student Book providing images, data, readings, and organizers for the study of planetary science,
- a CD-ROM in multiple platforms with interactive simulations and an extensive image database to enhance the concepts developed in the activities, and
- a complete kit of student equipment.

Continued on page 14
The 60 teachers and coordinators from the national trial sites began the trials with a meeting at the Lawrence Hall of Science in July 1997. Sites are currently located in Arizona, Arkansas, California, Colorado, Florida, Kansas, Massachusetts, Minnesota, New Jersey, Nevada, Ohio, Texas, Virginia, Washington, and Wisconsin.

The FOSS Middle School Program list-server and periodic meetings at the NSTA regional and national conventions provide opportunities for communication between the extended development team and the FOSS development staff. The trial teachers are able to share classroom experiences, ask questions of the FOSS developers, and receive ongoing updates and new resources. Site visits from the outside evaluator, along with in-person and phone interviews with teachers and students, will be added to the written and verbal teacher feedback to revise the Planetary Science mini-course for its commercial release in Fall 1998.

Some of the more interesting outcomes of the trials have been the extent to which the materials have supported and encouraged interdisciplinary teams. In Activity 3, Day and Night, students first work with models of the Earth and sun to determine the mechanics of day and night on Earth. This leads to the human construct of time zones, to the calculation of local noon, and to the difference in actual sunrise and sunset at the two edges of a given time zone. This is a perfect opportunity for the science teacher and the math teacher to work together on science/math integration in order to help students deal with these ideas from a variety of perspectives and to see the importance of mathematics in scientific inquiry.

When the students used models to explore shadows at different locations on the globe, it was an opportunity for the social studies teacher to also deal with the concepts of latitude and longitude, reinforcing the simulations in the science classroom. Organizing the shadow data on a two-coordinate graph provided another opportunity for math integration. The trial teachers appreciate the integration of different disciplines in the Planetary Science mini-course and the variety of readings provided for the students.

Development of the FOSS Middle School Program will require three years to complete all nine mini-courses and will involve the participation of curriculum developers at the Lawrence Hall of Science; local middle school teachers and students; scientists from the University of California; 20 school districts around the country; a nationally recognized educational publisher, Delta Education, Inc.; and the National Science Foundation. When complete, the FOSS Middle School Program will be a logical extension of the FOSS elementary curriculum.

Out of this World continued

NATIONAL TRIAL TEACHERS FROM GARLAND, TEXAS PARTICIPATE IN THE ROUND EARTH, FLAT EARTH ACTIVITY.
Astronomy, one of the ancient sciences, looks at the big picture—the biggest picture of all, the universe. With senses turned outward, the astronomer seeks answers to some of the most fundamental questions: Where am I? Where did everything come from and where is it going? How big is this universe? What else is in it with me?

The universe is a large subject for study—too large for one middle school mini-course to cover. For this reason, the FOSS introduction to astronomy is limited to our local neighborhood—our solar system. The Planetary Science mini-course has four main goals. Students will:

1. Understand that the sun, moon, Earth, and other planets comprise a dynamic solar system, the motions of which account for year, month (roughly), day, moon phases, and eclipses;

2. Use a variety of resources (laboratory materials, field observations, print, multimedia, internet) and inquiry methods to construct explanations for the structures and behaviors of objects in the solar system;

3. Think logically and critically to make inferences, solve problems, and reach conclusions about the solar system; and

4. Work collaboratively (as well as alone) to express understanding of important ideas associated with the solar system.

The Planetary Science mini-course curriculum structure uses two organizational themes. One is historical, guiding students to revisit some of the major observations and discoveries in astronomy. The second theme is starting the investigation on familiar ground, the Earth, and moving progressively further and further afield as the study advances. Combining these two curriculum strategies provides students with a sense of the sequence in which information was acquired as well as the accelerating rate at which planetary knowledge is growing.

The study of planetary science starts with an exercise in which the students create maps of their school grounds and mark an “X” on their maps where they can be found during science class. They then study images of their school from a series of six vantage points above the school, each ten times further removed than the previous. In this way, students are introduced to their home as an isolated planet in the vastness of space while keeping one foot securely planted, figuratively, on familiar turf.

After they revisit the historical evidence that informed ancient astronomers that the Earth was a sphere and understand the phenomenon of day and night, the students turn their attention to our nearest celestial neighbor, the moon. Several weeks are spent studying photos of the moon’s surface and conducting investigations to answer their questions: How big and how far away is the moon? Why does the moon change shape? What is the moon made of? What are all those circles on the moon? Where did the moon come from? Students study lunar geology and compare moon rocks and minerals to Earth rocks and minerals. They use this information to support and refute the popular theories of lunar formation. The curriculum uses a wide variety of teaching approaches, including simulations, data collection and analysis, field observations, artistic representation, and experimentation. By studying the moon in detail, the students develop the skills and strategies for investigating Mars and the other planets.
Those Bonehead FOSS Authors!

On October 15, 1997, I got a letter from Jessie Cox, a student in Mr. Coffee’s 4th-grade class in Durham, CA. Jessie represented the position taken by the whole class that there was something fishy about the bone count in the skull (FOSS Human Body Module, Bones activity). He reported that students in the class had researched the bones in the skull by going to an authoritative source, and the source reported a different count than the one suggested in the FOSS Human Body teacher guide. Jessie wanted to know what gives.

Fair enough. In order to prepare a thoughtful response, I first had to recall the difficulties we encountered at the time we wrote the guide eight years earlier. It all came back...it isn’t easy counting bones in the head! After some review, this was my response to Jessie. It may be of interest to others as well.

Dear Jessie,

I’m glad you looked into this issue of the bones in the head because it is a most difficult subject. I have found that counting bones is as much art as it is science. To this day different information sources give different numbers for the bones in the skull.

Here is how I approach the problem:

The skull has three main parts:

1. The cranium, which encloses and protects the brain.
2. The face, which surrounds and protects four of the five senses—smell, taste, vision, and hearing.
3. The jaw, which helps us deal with food.

The count for the cranium is pretty easy and all sources agree that there are eight complex plates connected with unique joints called sutures. I guess someone thought these jigsaw-like seams looked something like stitching, and they gave them this interesting name.

The face bones are a little more difficult. There is general agreement that there are eight of these that form the part of the face that is visible from the outside. This brings the total up to 16 so far. However, there are some bones on the roof of the mouth that are difficult to locate, and some books say there are two, and some say there are four. The book that we chose to accept as our authority said two, so that brings the total up to 18.

The lower jaw, which looks like one big U-shaped bone, is actually two bones connected right at the point of the chin. These two bones bring the total up to 20. Your encyclopedia says 22 at this point, so I just bet the authors agree with the experts that say there are four bones in the roof of the mouth (palate bones).

Technically, those are the bones of the skull. That’s probably why your encyclopedia says 22. However, you will notice that we added the line “other bones inside the head” to our Counting Bones sheet. Inside each ear are three tiny bones that perform essential roles in the process of hearing. Although they are not actually part of the skull, they are found in the skull, so we included them in this section. The six ear bones, added to the 20 skull bones, makes a total of 26, and that’s how we arrived at that number.

We should probably identify this section of the Counting Bones sheet as “Head Bones” rather than “Skull Bones.” That would be more accurate scientifically. We pride ourselves on the scientific accuracy of the program materials, and we are always pleased when people point out inaccuracies that we can correct. I think we will make this change when we revise the Human Body Module this year.

Sincerely,

Larry Malone
FOSS Co-Director

As a postscript I should add that we revised the FOSS Skull poster in 1996 to better show the bones of the inner ears, palate, face, and cranium. In the near future we will once again take up the issue of the head bones poster and prepare an even better exploded view that clearly shows the full complement of bones in an easy-to-count display. 

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Dear FOSS prisoner,

Mr. Coffee’s class is studying the human body. We have found that the World Encyclopedia and one other book said that the human skull has 22 bones. Your book says that there are 26. WHAT’S GOING ON ????

From Jessie

P.S. Even look on the piece of paper we sent you.

Jessie Cox
2508 S. 700 Ave
Durham, CA 95015

P.S. Please write back, tell us what happened!!!

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If you have access to the World Wide Web, the following sites provide a great opportunity to enrich FOSS science activities. Keep in mind that the World Wide Web is a fluctuating environment; links that you discover today may be gone tomorrow. You can find direct links to all of these Web references and more by connecting with the FOSS Home Page at <http://www.lhs.berkeley.edu/FOSS/>.

**General Resources**

The following link might be useful for extending several FOSS modules. Let us know how it helped you!

**Science Friday Kids Connection**
http://www.npr.org/programs/sfkids/

This site provides activities and resources on a variety of topics that extend the information in National Public Radio’s weekly program, Science Friday. From the Kids Connection, you can link to a variety of other resources for teachers and students, including Science Talk, an open forum for students, teachers, parents, and other knowledge seekers for sharing thoughts on science topics. This site also includes an archive of previous programs, many of which include audio versions for your listening pleasure. To hear the audio, you need to download RealPlayer from http://www.real.com/.

**Life Science Strand**

**Human Body Module**

**Human Anatomy Online**
http://www.innerbody.com/indexbody.html

This site contains over 100 illustrations of the human body with animations and thousands of descriptive links. Human Anatomy Online uses Java applets to show images and select anatomy parts. Java support must be enabled in your browser.

*Continued on page 18*
Online Connections continued

**Food and Nutrition Module**

**CyberDiet**
http://www.cyberdiet.com/

This site includes a variety of modules and databases that could extend your students’ experience with the Food and Nutrition Module. The site includes a Daily Food Planner, a Food Court where you can search for ideas for nutritious meals and snacks, a Fast Food Quest, a Food Facts database, and a Recipe Index. It provides several ways to interact with the modules and allows you to print your daily food plan and more.

**Earth Science Strand**

**Solar Energy Module**

**Adventures in Solar Gardening**
http://www.edu-source.com/solargar/solar_01.html

Adventures in Solar Gardening is an online diary of the planning, building, and use of an insulated growing frame, based on passive greenhouse technology. This page was first posted July 20, 1997 as a work in progress. Check back often and watch this diary of the progress in designing and building of an insulated grow frame. This presentation will include photos, illustrations, and text of an actual project that incorporates greenhouse technology.

**Landforms Module, Earth Materials Module**

**Running the Nile**
http://www.adventureonline.com/nile/index.html

In January and February of 1996, a team of kayakers attempted a “first ever” descent of the Victoria Nile River in Uganda, Africa. This site includes the Nile Classroom, a collection of resources for teachers and students designed completely by educators that are currently teaching in K–12 classrooms. This is a “rich” site with many opportunities for exploring the different aspects of this adventure. Activities that support the Earth Materials and Landforms Modules can be found in the Nile Classroom.

**Physical Science Strand**

**Models and Designs Module**

**Build-It-Yourself Junkyard**
http://northshore.shore.net/~biy/

Build-It-Yourself publishes an ongoing series of multimedia files (animated plans and building tips) which inspire kids between 8–16 years to build whimsical contraptions using commonly found materials. This program complements math, science, and art curricula. Build-It-Yourself projects encourage the purchase of tools, engines, and materials from an electronic catalog. The software that you can download from this site is available for PCs only.

Continued on page 20
The following selections include books that are not necessarily new but are good books not included in past FOSS newsletters.

**Grades K-2**

*From Wood to Paper*

A picture book with text kindergartners will enjoy listening to as teachers read about the process of how paper is made and what happens to the finished product. (A Start-to-Finish Book.)

*Messy Bessey’s Garden*

Messy Bessey discovers that with proper care, her garden will flourish. Especially for first graders.

**Grades 3-4**

*How Tall Was Milton?*

A fairy tale king announces a contest for the best method to measure the height of the village’s friendly giant. Villagers learn that it is necessary to have a standard to measure accurately and consistently. (This book is out of print, but you may find a copy in your school library.)

Continued on page 20
Online Connections continued

**Models and Designs Module**

Design Your Own Robot
http://www.tcm.org:80/cgi-bin/dynamo/galleries/robots/design/robot.html

The Computer Museum Network has created this interactive site where you can create and test your own robot design. Your challenge is to have the robot accomplish six tasks. As you engage in this activity, you will learn something about the elements of robot design. When you are finished building each robot, you can link to a Web site showing a robot similar to the one you've built but operating in a real-world setting. The interactive portion of this site requires Macromedia Shockwave which you can download from http://www.macromedia.com/shockwave/.

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**Scientific Reasoning Strand**

**Measurement Module**

**Metric System History**
http://www.geocities.com/Athens/Acropolis/1793/history.html

A timeline depicting the major events in the development of the metric system is available at the site. If you go back to the Home page (http://www.geocities.com/Athens/Acropolis/1793/index.html) you can view the latest news from the Metric Action Committee, take a metric system quiz, and link to other metric resources.

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**Wordsmiths continued**

**Rubber-Band Banjos and Java Jive Bass: Projects and Activities on the Science of Music & Sound**

This book presents the science of sound and music, including how sound is made, how the ear hears sounds, and how different musical instruments are made. Perfect for projects students may want to carry out on their own after completing the Physics of Sound Module.

**Adventurous Spirit: A Story About Ellen Swallow Richards**

A biography of Ellen Swallow Richards, the first woman to study at the Massachusetts Institute of Technology and the first professional woman chemist. She was one of the first to study water pollution and how use science to improve the home environment.

**Island of the Blue Dolphins**

Karana, a native American, lived alone for years on an island in the Pacific. This is the story of how she kept herself alive by building shelter, making weapons, finding food, and fighting her enemies, the wild dogs, while waiting to be rescued.
Of the 12 titles in the series, check out the following as possible extensions to FOSS modules.

**Electric Current**  
**Magnetism and Electricity Module**  
I.M. Richman’s alarm system has been tripped. Did Mary Murray attempt to steal his ping pong trophy? Or is there something about the electric current in Richman’s alarm system?

**Sound**  
**Physics of Sound Module**  
Was Shep ten seconds late sounding the cannon for the town celebration? Or will Judge Stone and the Science Court team find something special about the way sound works?

**Water Cycle**  
**Water Module**  
Meteorologist Maria Hernandez takes the stand as an expert witness in the case of Pip Peterson’s leaky pipes. Are the pipes really leaking? Or are they victims of the water cycle?

**Work & Simple Machines**  
**Levers and Pulleys Module**  
Who’s the laziest worker at Robocorp? The scientific definition of work may reveal a surprising answer.

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**Software Reviews**

All of the software programs reviewed in this article are available from:  
Tom Snyder Productions  
80 Coolidge Hill Road  
Watertown, MA  02172  
Phone: 1.800.342.0236  
http://www.teachtsp.com/index.html

**Neighborhood MapMachine**  
**Landforms Module**  
This easy-to-use tool enables students to create, navigate, and print maps of their own neighborhoods, other communities, or imaginary places using objects such as roads, trees, buildings, and parks. As students map out their towns, they learn essential geography skills such as direction, distance and scale, grid coordinates, and symbols. This is a nice extension to the Schoolyard Mapping activity in the Landforms Module.

**Science Court**  
*Science Court* is an exciting new CD-ROM series that mixes animated courtroom drama, hands-on science activities, and humor to teach students fundamental science concepts and model good scientific practice. As each case unfolds, students examine the facts and perform hands-on experiments to help them predict the verdict. Science Court is now part of the children’s programming line-up on Saturday mornings on ABC-TV. Grades 4–6

**Science Court**

*Science Court* is an exciting new CD-ROM series that mixes animated courtroom drama, hands-on science activities, and humor to teach students fundamental science concepts and model good scientific practice. As each case unfolds, students examine the facts and perform hands-on experiments to help them predict the verdict.

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Laugh About it Later?

It probably happens to everyone. A student says something or an incident happens during class that takes you back or strikes you as funny, but, being in tune with your students’ feelings and a need to remain in control, you can’t appreciate the amusing aspects until much later. And so it goes with FOSS! The following situation was described by our administrative assistant, Cheryl Webb, in an e-mail message to Linda De Lucchi, FOSS Co-Director.

Slurping the Sludge:
An Adventure with Mock Rocks
Linda: Becky, a Poison Control representative from Arizona, called to ask about Mock Rocks. She said a child at a school had ingested a Mock Rock. Their office was called. She needed to confirm the ingredients. She had the recipe in hand and didn’t see any problem with what was there. I mentioned that the only thing I could come up with that might be of concern is how the gravel was colored. I told Becky that I wanted to check the packaging for information and that I would call her back. On the “Gravel” bag it says it is colored by an epoxy color coating, specially formulated for its non-toxicity to aquatic life. On a bag of another color it read that it was non-toxic to plants and animals as well as aquatic life. (You figure the fish have got to live through it!) I tried calling the company who makes the color coating.

I also called around locally and tried talking to a few people who all said “probably inert and would pass through the system unchanged” but no one would say that “officially.” I called Becky back at the Arizona Poison Control center. I gave her what information I could (most likely the Mock Rocks would cause no problem if eaten [provided properly chewed] and the oyster shells didn’t cut any tissue).

Becky had called the school back and found out the kids were drinking the sludge from the Mock Rocks. The staff there all thought that no one had actually swallowed a rock.

(Epilogue: We haven’t heard of any further incidences in which students have tried to taste the Mock Rocks. Maybe we should suggest adding more alum to the recipe. That would certainly make the attempt bitter and definitely not sweet.

On a serious note, the FOSS staff at the Lawrence Hall of Science and at Delta Education consider safety to be an important issue. Materials Safety Data Sheets [MSDS] are kept on file for all materials in FOSS kits for which they have been identified. And the most important rule to enforce with your students is not to put anything in their mouths unless you have told them it is okay. If you have any questions about the safety of FOSS materials, please check with the FOSS staff at LHS, 510-642-8941.)

Have you got any humorous stories to share that stem from your experiences with FOSS and your students? We’d love to hear them. You can send them to the FOSS Newsletter, Lawrence Hall of Science, University of California, Berkeley, CA 94720-5220. Please send your name and address with the story, although we would be happy to publish them anonymously.
FOSS Institutes

Delta Education will host 2-day Informational Institutes this academic year in conjunction with the NSTA Area and National Conventions. These Institutes are designed for all educators—lead teachers, administrators, curriculum coordinators, university methods instructors, science committee members, and school board members—who are interested in finding out what FOSS is, who developed it, what philosophy of education it supports, and to begin networking with other FOSS users. A lot of time at these Institutes is spend with the program materials, doing activities and engaging in inquiry.

During the summer Delta hosts Implementation/Leadership Institutes. These meetings are designed for educators who have adopted FOSS and are into their implementation process. Some time will be spent working with the FOSS materials, but a greater proportion of time will be spent delving into issues of management, teacher preparation, materials maintenance, and a host of other subjects.

Most Institutes are led by FOSS development staff. There is no charge, but participants must register in advance to attend. Times and location are listed in the calendar. To secure your spot at the Institute of your choice, call, write, or FAX.

Pam Frisoni
Delta Education, Inc.
5 Hudson Park Drive
Hudson, NH 03051
Phone: 1.800.258.1302
FAX: 603.886.4632

FOSS NSTA Pre-Convention Informational Institutes

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<td>April 14-15, 1998</td>
<td>Las Vegas, NV</td>
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<tr>
<td>October 27-28, 1998</td>
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Implementation/Leadership Institutes

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Special Institute: Research into Practice

Designed for teachers with at least three years of FOSS experience

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☐ Yes! I’m interested in attending a FOSS Informational Institute.
☐ Yes! I’m interested in attending a FOSS Implementation/Leadership Institute.

Please send me registration information for the ____________________ Institute.
(Date and Location)

Name

School District

Title

Address

City State Zip Daytime Phone

☐ I did not receive this FOSS newsletter in the mail. Please add my name to the mailing list.
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 World Wide Web with FOSS. Send your contributions to:

FOSS Newsletter
Lawrence Hall of Science
University of California
Berkeley, CA  94720-5220

The deadline for submissions to the next issue is July 13.
We’re waiting to hear from you.

Delta FOSS Sales Division
Tom Guetling
V.P. Sales & Marketing
Hudson, NH
800.258.1302

Pam Frisoni
Adm. Asst. Sales & Marketing
Hudson, NH
800.258.1302

Regional Sales Managers
Susan Hardy
Charlottesville, VA
804.296.2068

Verne Isbell
Arkadelphia, AR
501.246.2949

Comer Johnson
Folsom, CA
916.983.1702

Jeff Lorton
Minneapolis, MN
888.824.6180

Tom Pence
Oswego, IL
708.951.6049

Dean Taylor
Flagstaff, AZ
520.527.8717

Lisa Wood
Pepperell, MA
800.258.1302

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...because children learn by doing®

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For information about purchasing FOSS products or for the phone number of your regional representative, call Delta Toll Free at:
800.258.1302
Or FAX at:
603.886.4632

Delta Education
5 Hudson Park Drive
Hudson, NH  03051

For information about the development of the FOSS program, contact:
Larry Malone or
Linda De Lucchi

FOSS Program
Lawrence Hall of Science
University of California
Berkeley, CA 94720
voice: 510.642.8941
FAX: 510.642.7387
Internet:
lmalone@uclink4.berkeley.edu

FOSS on the World Wide Web:
http://www.lhs.berkeley.edu/FOSS/