In Fall 2015, we announced the release of FOSS Next Generation K–5. We’re happy to now update that news to announce that all FOSS middle school courses are final or in final development and that FOSS Next Generation K–8 will soon be complete. In addition to the new K–8 FOSS program, there will be new professional learning tools for teachers at all grade levels and new online assessments to support in three-dimensional learning.

The FOSS Project staff and Delta Education are dedicated to partnering with new and experienced users of FOSS to plan a smooth transition to FOSS Next Generation K–8.

FOSS K–8 is a coherent program based on learning progressions that guide nine years of a student’s academic career. Some of the effective teaching strategies of the elementary program have been carried through to middle school, and some of the successful instructional tools from middle school have been incorporated into the K–5 program. A unified K–8 program strengthens every FOSS elementary module and middle school course. A consistent K–8 program benefits all students.

FOSS Next Generation K–8 is an active learning science program that engages students with natural and human-made phenomena; the program features instructional guidance, student equipment, integrated student reading materials, digital resources, and a fully integrated assessment system. FOSS has always utilized an inquiry approach to teaching and learning, but the National Research Council’s A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012), on which the NGSS are based, has provided a new way for the FOSS developers to design learning experiences and frame focus questions for learners. Guided by the Framework, FOSS provides a school science curriculum with a cohesive approach at each grade level and articulated learning progressions within and between grade levels. The NGSS gave us the opportunity to look at things from a grade-level perspective. Now that we know what teachers are being asked to teach at each grade level, we can thoughtfully plan and integrate with Common Core ELA and mathematics in a grade-appropriate manner.

When we first began working on learning progressions for FOSS Next Generation K–5, we quickly came to the conclusion that to stop

Continued on page 2
Next Generation continued

there was to do a disservice to our students. We needed to develop those progressions from kindergarten through grade 8.

In FOSS First Edition K–6, we developed the multisensory approach to active learning of science, and in the Second Edition (K–6), we refined and enriched that approach by integrating quality reading materials. FOSS Middle School came into being in 2000, and the role of technology became an important new tool for teaching and learning. When FOSS Third Edition K–6 fully integrated the use of science notebooks, outdoor applications, and formative assessment with strong conceptual frameworks through the science strands, FOSS Middle School soon followed suit.

In FOSS Next Generation K–8, we’ve built upon all of these previous editions, strengthening and making more explicit the connections to the three dimensions of science, to engineering teaching and learning, and to the Common Core State Standards (CCSS) for English Language Arts at each grade level.

The FOSS instructional design is, at its core, three-dimensional learning. To that end we strive to seamlessly:

1. communicate the disciplinary core ideas (content) of science;
2. facilitate student engagement in science and engineering practices (inquiry methods) to develop knowledge of the disciplinary core ideas; and
3. help students comprehend the crosscutting concepts (overarching concepts) that connect the learning experiences within a discipline and bridge meaningfully across disciplines as students gain more and more knowledge of the natural world.

The pedagogy of our program is now consistent across K–8 and is applied in a way that supports students and teachers appropriately at each grade level.

The NGSS describe the knowledge and skills we expect our students to be able to demonstrate after completing their science instruction experience. The expectations are demanding and include no small measure of ability to communicate scientific knowledge. The ability to communicate complex ideas assumes that students have had a significant amount of experience and practice building coherent explanations, defending claims, and organizing and presenting reasoned arguments in the context of their science curriculum.

FOSS Next Generation experiences will prepare your students to meet these expectations; students actively interact with objects, organisms, and systems to learn about natural and human designed phenomena.

FOSS Next Generation is strongly grounded in the realities of the classroom and the interests and experiences of the learner. It is crafted with a teaching philosophy that embraces the 21st-century skills: collaborative teamwork, critical thinking, and problem solving that applies the content of science and engineering. FOSS Next Generation curriculum design promotes a classroom culture that allows both teachers and students to assume prominent roles in the management of and responsibility for the learning environment. The content in FOSS is teachable and learnable over multiple grade levels as students increase in their abilities to reason about and integrate complex ideas within and between disciplines.

FOSS Next Generation is built on the assumptions that understanding of core scientific phenomena and how science functions are essential for citizenship. And, as always, FOSS believes that all teachers can teach science, and that all students can learn science.

For more information, to request a presentation, or to inquire about piloting, please contact your local FOSS sales manager. deltaeducation.com/sales

To request a program sample, please visit deltaeducation.com/sampleFOSS.
FOSS Next Generation K-8 Scope and Sequence (NGSS National)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Physical Science</th>
<th>Earth Science</th>
<th>Life Science</th>
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<tbody>
<tr>
<td>6–8</td>
<td>Waves* Gravity and Kinetic Energy*</td>
<td>Planetary Science</td>
<td>Human Systems Interactions* Heredity and Adaptation*</td>
</tr>
<tr>
<td></td>
<td>Chemical Interactions</td>
<td>Earth History</td>
<td>Populations and Ecosystems</td>
</tr>
<tr>
<td></td>
<td>Electromagnetic Force* Variables and Design*</td>
<td>Weather and Water</td>
<td>Diversity of Life</td>
</tr>
<tr>
<td>5</td>
<td>Mixtures and Solutions</td>
<td>Earth and Sun</td>
<td>Living Systems</td>
</tr>
<tr>
<td>4</td>
<td>Energy</td>
<td>Soils, Rocks, and Landforms</td>
<td>Environments</td>
</tr>
<tr>
<td>3</td>
<td>Motion and Matter</td>
<td>Water and Climate</td>
<td>Structures of Life</td>
</tr>
<tr>
<td>2</td>
<td>Solids and Liquids</td>
<td>Pebbles, Sand, and Silt</td>
<td>Insects and Plants</td>
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<tr>
<td>1</td>
<td>Sound and Light</td>
<td>Air and Weather</td>
<td>Plants and Animals</td>
</tr>
<tr>
<td>K</td>
<td>Materials and Motion</td>
<td>Trees and Weather</td>
<td>Animals Two by Two</td>
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</tbody>
</table>

*Half-length course

The Next Generation program consists of three modules at each grade for K–5 and 12 courses at 6–8. For a detailed breakdown of the 12 middle school courses, visit http://www.deltaeducation.com/foss/middle-school.

See page 19 for a list of the workshops we’re hosting this summer at the Lawrence Hall of Science!

FOSS Next Generation K-8 Scope and Sequence (NGSS CA Integrated)

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<td>Waves*</td>
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</table>

*Half-length course

This scope and sequence was developed for the California NGSS.
With great sorrow the FOSS family announces the passing (Thursday, December 15, 2016) of Dr. Larry Lowery, the original principal investigator (PI) for the Full Option Science System project, funded by The National Science Foundation. In 1989, when Linda De Lucchi and I, co-founders of the FOSS program, were wrestling with the design and plan of action for our newly funded project, we approached Dr. Lowery to join the project to act as its PI and academic leader. At the time Larry was professor of Education in the University of California at Berkeley Graduate School of Education. At this time in his career he had already acted as PI for the Family Math and EQUALS programs at the Lawrence Hall of Science. His interest in cognitive science and learning theory and generous commitment of time made him an obvious candidate to assume the academic leadership of the fledging FOSS project. What many people outside the particular micro-industry of science curriculum development don’t understand is that the work is a concentrated team effort. Curriculum development in practice is a long, continuous conversation about the multitude of variables that conspire to produce a coherent instructional product. Larry brought two elements to that conversation: the concept that the program we were attempting to develop required a serious and focused intellectual commitment on the part of both students and teachers, and evidence of learning (assessment) should be incorporated into the design of the instructional product. Larry inserted these two pivotal ideas into the DNA of the FOSS development team.

And even after retiring from the Graduate School of Education and as PI of the FOSS project in the late 1990s, Larry continued to represent the FOSS Program specifically, and effective science instruction generally in multitudes of invited addresses and presentations at professional organizations and educational institutions around the country and internationally (China, Japan, Czech Republic, Finland). We considered him our FOSS ambassador at-large, and he directly affected the practice of thousands of educators. We remain indebted to Larry for his legacy contribution to the development of the vision that continues to guide our ongoing success.

All those who knew Larry as science education guru, author of a small library of children’s science books, amateur magic enthusiast (he was always ready with a deck of cards), or the tireless advocate for Big Little Books, recognized him for his radiant smile and his readiness to play nice with others. I represent the entire FOSS staff, the extended FOSS family of consultants, and the entire Delta Education staff, when I acknowledge Larry as a thoughtful, inspirational colleague and most of all I will remember him fondly as a good friend. Rest in peace, my friend, job well done.

Larry’s professional awards and recognitions bear testament to his remarkable influence. Among others, he received the 1975–76...
Dr. Lowery’s FOSS Newsletter Articles

“The Importance of Understanding Child Development in Curriculum Development,” Spring 1993


“Communities of Practice,” Fall 1994

“Partnering with Researchers,” Spring 1995

“Benchmarks and Standards,” Spring 1996

“The Nature of Learning,” Fall 1997

“Strategies for Instruction,” Spring 1998

“If It Ain’t Broke: The ‘Why’ Behind the FOSS Revisions,” Fall 1999
A cross the country, events such as science fairs attempt to deepen students’ knowledge and investment in science education. Research has demonstrated that science fairs can increase students’ desire to go into the STEM fields (Sahin, 2013), but that the time-consuming process is not equitable for all students and does not reflect the work of scientists (Hampton & Licona, 2013). Most students do not have the time management, motivation, or resources needed to pull off a lengthy self-directed project. Some students get “help” from parents or other authority figures, who, in a perfect world, guide students but more often end up doing the majority of work for students. Science fairs can also lead to a false impression that science is a special event that happens occasionally and follows a lockstep set of practices, with requirements often referencing the “Scientific Method” (a one size-fits-all method that scientists don’t prescribe to). So if this is true, how do we make visible to parents and to community members the science and engineering that students do every day? How do we come together to celebrate science? Some teachers host curriculum nights to showcase projects students have worked on. Some host something like a “Science Night” where parents can come to the school after hours to experience what students engage in during the school day.

In April 2016, the Guiding Education in Math and Science Network (GEMS-Net) from the University of Rhode
Island (educators who partner with 47 public schools throughout the state) took this one gigantic step further. They held a GEMS-Net Family Science Expo on a Saturday from 10 a.m. to 2 p.m. The Science Expo was free and open to the public and featured 27 activities that families could engage in together, based on the K–8 FOSS Curriculum. This expo was a big way to celebrate the 20th anniversary of the URI GEMS-Net project. It was a way to showcase the work of teachers and students throughout the state and the progress STEM education has made locally in the past 20 years.

During the planning leading up to the event, the GEMS-Net staff, volunteers, and teachers didn’t know what to expect and were amazed to see that over 2,000 guests—students and their families—arrived to experience multiple science and engineering investigations. The families enjoyed working together through activities students would do in school and connecting to environmental education field experiences that extend the classroom learning. The goals of the event were to publicly celebrate the hard and productive work of teachers and students. The media often reports on the challenges and pitfalls of teaching and learning. GEMS-Net wanted to showcase the rigorous and relevant work in classrooms. This was one step in the direction to ultimately garner public support for elementary school science. An equally important goal of the event was to relate elementary school science to college and career choices. Parents and children had opportunities to investigate a variety of university majors in the STEM field and ask questions of the professors. The three-dimensional learning progressions from kindergarten through middle school were apparent. Moreover, the connections between the content, practices, and thinking that were happening in elementary and middle school were clearly aligned with the goals and activities of university science and engineering colleges. Additionally, the Rhode Island Environmental Education Association (RIEEA) member organizations provided a meaningful link between the active science done in school and science within the students’ local community.

**What Is GEMS-Net?**

GEMS-Net, founded in 1996, is a K–16 STEM Pipeline working in partnership with 47 public schools throughout the state of Rhode Island and the University of Rhode Island’s (URI) School of Education. Teachers in GEMS-Net districts receive ongoing professional development in STEM education through a multi-faceted approach. All teachers participate in contextualized workshops designed around the specific FOSS modules that are facilitated by GEMS-Net education specialists. University scientists, engineers, and informal educators from around the state join the workshops bringing expertise that help develop teachers’ content knowledge. Classroom coaching and other supports available to teachers foster a continuous improvement in teacher practice and student learning.

Through a research study funded by the Rhode Island Foundation, GEMS-Net discovered that 77 percent of Rhode Island children surveyed in grades K–8 enjoy learning about science in school, yet only 25 percent of the same children would consider pursuing a career in science or engineering, Director Dr. Sara Sweetman and her team hypothesize that if we increase children’s understanding of STEM career opportunities they may stay interested in science throughout schooling. By having URI departments provide information to students and parents about appropriate pathways, GEMS-Net hopes to connect the pipeline.

The same research found that only 34 percent of children relate science from the classroom lessons to life outside of school. Through these activities and more, families and other community members will discover the rigorous learning opportunities that local public schoolchildren engage in through support from GEMS-Net.

**2,000 Visitors, Staff of Four—How’d They Do It?**

Even though the core GEMS-Net staff is made up of four full-time and one part-time university faculty and staff, they tapped into their much larger collaborative network to successfully meet the goals of the expo. The excitement around what is happening in the classrooms and the opportunity to share this with the public was the motivation for 200 volunteers on the day of the event, some of whom also worked behind the scenes before the event. The 50 teacher leaders collected student work and designed posters that were displayed during the event (see page 9 for a sample poster) and many of them spent the day running activities. Pre-service teachers enrolled at URI also learned the lessons and worked alongside the teacher leaders. Brittany Borkum, a preservice teacher from URI reflected on the experience, “I loved the experience of working at the GEMS-Net Expo because it was so much fun working with different and well-trained elementary school teachers as a networking experience, and working with so many students who were eager to explore science.”

The event was held at the Ryan Center, an arena for public events located on the University of Rhode Island’s Kingston Campus and seemed like the perfect venue.

*Continued on page 7*
Celebrating 20 Years continued

for our celebration because it connected to the goal for families to see the pathway towards STEM careers and university science and engineering programs.

Having a discounted fee for the venue from the university helped keep the event free and open to the public. The event also received funding and sponsorship from a variety of sources; for example, the Dean of the School of Education from URI provided lunch for all 200 volunteers, and the Rhode Island Foundation provided transportation from the capitol city in order to increase access to the expo. Food was available for purchase for event-goers through the Ryan Center food court. The GEMS-Net team will be looking for sponsorship from local businesses in the future in order to continue this as an event that is open and free for all families.

Lynn Dougherty, principal of Wakefield Elementary School, reflected upon the event. She said,

I didn’t know exactly what to expect as I walked into the Ryan Center for the GEMS-Net Science Expo. Upon entering, I was amazed at the size of the exhibit hall and the number of students and families who were there participating. I was also in awe of the staff and teachers who volunteered their time and expertise to make this event so special. As I walked from station to station, I was impressed with the level of engagement and excitement at each of the tabletop activities. I saw many families from Wakefield School there and they had such high praise for this type of community event. As I made my way outside to leave, I made sure to stop at the telescope station to take a look at the Sun, which was an amazing way to spend my time at this event.

The large open space seemed to hold the number of people really well. The layout of the event was organized by grade level. There were four large and long tables for each grade level with a life, earth, and a physical science activity from each module. Also in each grade-specific cluster of tables was a table for an environmental education organization that connected to the grade-level module. Save the Bay was one such organization that presented with touch tanks—a direct extension of the Structures of Life Module. During the school year various environmental education resources throughout the state work with GEMS-Net students on a regular basis to make connections between in-school and out-of-school experiences and opportunities.

This event truly ran without a hitch due to the collaborative nature of the program and the organization from GEMS-Net staff and interns. Weekly meetings with the staff and student interns helped to ensure tasks were covered and completed. Getting funding from businesses will allow the GEMS-Net staff to work on marketing and dissemination of information ensuring that the event is covered by local news.

**Nuts and Bolts**

Advertising for the event happened through social media venues like Facebook and Twitter, and also through free local newspaper calendar listings. All of the students in GEMS-Net schools, approximately 16,000 students,

““For young students to be able to look at something in their everyday life, like [the] Sun, with new eyes, up close, and see its flaws and motion, it sparks questions and ignites the imagination. Even for the adults, it is hard to suppress that childhood joy of something new and unusual when looking at [the] Sun, directly, for the first time. If nothing else, reflecting on something 93 million miles away, a distance that takes light over eight minutes to travel, can give you pause to your everyday life. That light outside… is over eight minutes old. Add a second if it is bouncing off of [the] Moon.”

—Doug Gobeille, Ph.D., Director of the URI Observatory, Department of Physics

““As a school leader and advocate for science in school communities the GEMS-Net Expo provided a space for families to actively engage in science that students are experiencing every day in our schools. It allowed our student scientists to share their learning, interact with professionals, make connections, and ultimately have fun! The Expo elevated GEMS-Net and science in our community. The only disappointment of the day was that it had to end.”

—Steven Morrone, Assistant Principal of Teaching and Learning, Chariho Middle School”
brought home an invitation via school websites or backpack mail. The Rhode Island Foundation funded a school bus to provide Providence students transportation to the event, about a 45-minute drive away. GEMS-Net impacts approximately 16,000 students each year; many of these students came to the one-day event. Students from districts outside of GEMS-Net—and even from beyond Rhode Island’s borders—also attended this event.

The university faculty were impressed by the expo and have asked for the event to become a regular occurrence. We have heard from more science departments that they would like to be a part of the event. The connection between the in-service and preservice teachers was an unexpected benefit. The in-service teachers were impressed by the involvement and enthusiasm of the preservice teachers and the preservice teachers felt that the expo afforded them a unique learning experience.

In conclusion, getting volunteers and engaged teachers was key to pulling off an event of this size. Teachers were excited to be given an opportunity to share their hard work and to show the public the work their students engage in daily. Having a committee to organize the numerous details and giving teachers specific tasks that do not take a lot of time (teachers have a lot to do!) makes the event less overwhelming and created more buy-in from teachers. This celebration was not mandatory for our teacher leaders and yet we had approximately 80% participation from this leadership group. We had one lesson from each course at each grade level, which was specific and easy to tackle. Reaching out to partners or collaborators and including all stakeholders builds community for all.

For more information about GEMS-Net https://www.deltaeducation.com/SSIDEL/media/Downloads/FOSS/foss_gems-net_stem_article.pdf

References:
In just about every state in this country, the Next Generation Science Standards (NGSS) have been adopted explicitly, or insinuated implicitly, into the contemporary vision of science education. So, in fact, or at least in spirit, the NGSS provide the light illuminating the vision of classroom science for the whole country. So, I continue to ponder the elements of a coherent vision of action for the way forward.

The first part of my rumination process is determining what’s new in this iteration of science standards. Traditionally, standards have described what to teach (the core ideas of science) with little regard for how it was taught. The influence of the National Research Council’s *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012) and, by extension, the NGSS have brought fresh focus on not only what to teach, but how to teach as well. There is not really much that is new in the *what to teach*, but there is a lot to think about in the *how to teach*. The how to teach is not described explicitly in these documents, but the emphasis on the science and engineering practices implies plenty. This emphasis on practice proclaims in no uncertain terms that the expectation is that students will learn science by engaging in authentic learning experiences with important scientific phenomena, modeling the activities of scientists.

If I’m interpreting the words correctly and reading between the lines accurately, NGSS is saying students should engage their science studies in an active learning environment. First element of a vision of an NGSS classroom: active learning. For us at FOSS, that’s the easy part to envision—students actively interacting with objects, organisms, and systems and learning about natural and human conceived phenomena. This is how FOSS has always worked—good old-fashioned hands-on activity. But that is really only the starting point; now the tricky bit emerges. For all time, the detractors of hands-on science have dismissed hands-on science as “just play.” (That characterization is just plain wrong.) But the rest of the modern vision of science education concentrates on the instructional practices that make hands-on transcendent. And it is in this instructional space in which I have lately been interested or, more accurately, impassioned. There is an opportunity for a revolution in American education that may emanate from the experience in the science curriculum. Because in order to realize the vision of NGSS there will need to be a revolution in teaching and learning; not just in teaching, but even more importantly in learning. This suggests a significant transition from an emphasis on good teaching to a vigorous emphasis on good learning. High functioning classrooms have shared responsibility: the teacher is responsible for facilitating instruction; students are responsible for learning. Simple! Maybe yes/maybe no. Both sides of the responsibility equation are hard. If either party is poorly prepared or lacks the vigor—no results.

The instructor/learner interface is critically important. The goal of this engagement is to forge a culture of learning. The unfortunate fact is that a teacher cannot provide students with knowledge. Teacher can provide information in multitudes of forms—first-hand experience, video presentation, digital simulation, text, focused discussion, outdoor experience, etc. Acquisition of information is the foundation of learning, but acquisition of information does not rise to the level of knowledge. The goal is for students to transform information into knowledge, a much more complex cognitive activity. For generations we have valued the amount of information students have been able to accumulate and reproduce upon examination. Information is the raw material from which knowledge is constructed, not the complex cognitive products (knowledge) we should be valuing. I’ll always remember a question/statement communicated to me by Dr. Richard Shavelson, a prominent assessment researcher at Stanford University. He said simply, “Why assess what we teach students, shouldn’t we be assessing what they are able to do with what they have been taught?” In other words, what meaning are students able to make of the experiences (information) we provide them.

The NGSS teacher needs to assume a new role: learning-space engineer. By learning-space, I’m not thinking of the physical terrain (although it does factor into the total concept of learning-space). The learning-space I am most interested is the psychosocial learning space—the intellectual culture in the classroom community. For this particular kind of ultra-productive intellectual community to establish and thrive requires the development of a culture of learning. This particular
culture does not spring forth spontaneously for a variety of reasons. It must be introduced and nurtured carefully and reflectively. This can be particularly challenging with older (grade 4–8) students who have spent most of their academic careers in a competitive learning culture where very different behaviors and products are expected and rewarded.

What are the characteristics of this learning-space classroom? Here is a bullet list of indicators, which is not exhaustive by any stretch, but a sampling. Bear in mind, each bullet is like a chapter heading in a book about learning space culture; each bullet could and should be elaborated with its own essay.

Following are my expectations for a learning space in an NGSS classroom.

- The class has adopted a code of norms for responsible, civil, and intellectual engagement.
- Students understand that one of their most valuable learning assets is shared thinking with peers.
- Students readily share information and thinking during formal and informal sense-making activities.
- Students understand that learning is hard work and they accept that they may progress through several stages of confusion and partial knowledge before “getting it.”
- Students use data to develop evidence to support ideas.
- Students endeavor to communicate their emerging knowledge as effectively as possible.
- Students accept (relish) formative assessment, recognizing it as valuable information contributing to their learning progress.
- Students and teachers assume a growth mindset, in which the ability to continuously improve is communicated both implicitly and explicitly.
- Students come to understand that learning is not “being right.”
- Students develop habits of mind that allow them to think productively about novel problems.

The learning space is a psychosocial condition in a classroom, a condition marked by a culture of collaboration and mutual support, organized to develop and advance scientific knowledge. The implicit prime directive of the NGSS is to transform classrooms into communities of young scientists and engineers. If you substitute the word “scientists” for “students” in the bullet points listed above, the statements hold true for the enterprise of professional science.

In the Framework and the NGSS, the explicit “what to teach” has been only subtly contoured and freshened, but the implicit “how to teach” is where the deep, challenging message resides. Fortunately, the FOSS program developers have been providing instructional resources in response to this challenging vision for decades. And the most recent reinvention of the program (FOSS Next Generation) has the potential to contribute to the process of creating a vision of your science curriculum going forward.

3D Vision of Teaching: Transforming Science Instruction Using FOSS
By Kristen Moorhead, FOSS Consultant, and Shannon Dadlez, Project Director, Riverside Unified School District

“What did you SAY to the boys over there?” an incredulous teacher asked me while visiting her classroom.

I replied, “I asked them what their ideas were about the investigation.”

“They NEVER participate; I can’t believe they are actually talking and writing about science!” exclaimed the teacher.

Statements like this that express excitement and surprise about student motivation to talk and write about their science ideas are heard throughout Riverside Unified School District (RUSD). Through California Mathematics and Science Partnership (CaMSP) grant funding, 59 teachers representing 23 elementary schools began using FOSS to implement the Next Generation Science Standards (NGSS) science instruction in August 2015. Teachers immediately saw a change in their students as they learned to shift their instruction toward facilitative three-dimensional learning.

Some might say that implementing NGSS is a daunting task. As a result of inviting teachers to experience what it means to figure out and explain phenomena using FOSS, the vision of NGSS came alive very quickly, much more quickly than expected.

We are now in year two of the grant period and teachers are in their second year of implementing FOSS physical science modules at grades K–5 and the FOSS Weather and Water Course at grade 6.

Students are now in the driver’s seat when it comes to making sense of phenomena. They know their role is to wonder about phenomena, investigate to collect data, develop models, and construct explanations using

Continued on page 12
evidence. This has led to students and teachers saying the following commonly heard statements.

“We don’t just watch; we get to DO science!” —sixth-grade student

“My kindergarteners are learning vocabulary and science concepts and remembering it well enough to go home and tell their parents about it.” —kindergarten teacher

“Science investigations were all the kids wanted to talk about during student-led parent-teacher conferences.” —teacher

The professional development program of the RUSD CaMSP Grant was carefully crafted to increase teacher content and pedagogical knowledge related to science teaching and learning. Because teachers immediately began applying their learning to their work with students using FOSS modules, three big transformations started happening quickly.

**Transformation 1: Dramatic Increase in Students’ Opportunities to Learn**

In order for students to learn science, they need an adequate amount of instructional time focused on investigating natural and designed phenomena. Before the start of the grant, nearly 50% of participating teachers taught science less than 30–45 min per week. One year later, 94% of participating teacher reported teaching science at least 2.5 hours per week. In addition, the majority of teachers reported an improvement in attendance on days when science was being taught; students did not want to miss out! Opportunity for students to learn science has been a persistent barrier throughout the country as described in the “School Resources for Science Instruction” section of NGSS Volume 2, Appendix D (The National Academies Press, 2013). By using FOSS, each teacher participating in the grant had the material resources necessary to teach science with active investigation at the center of the learning.

**Transformation 2: Experiencing How Science Impacts Writing**

Teachers have learned to capitalize on the synergy with the Common Core State Standards for English Language Arts (ELA) by using the connections built into each FOSS Investigations Guide and the Science-Centered Language Development chapter. Instructional discussion techniques in FOSS led teachers to conduct more discussions and have students engage in collaborative conversations in other curricular areas. Once students were able to express their ideas verbally, they were able to put those ideas in writing, backed up by evidence. Use of evidence in science led to more use of evidence in ELA. Teachers were naturally creating derivative writing products with students before we even had a chance to “teach” them about it! Students were easily creating derivative writing products (e.g., science reports) even before we taught them how.

Furthermore, derivative writing products emerged from expository writing assignments. A first-grade ELA expository class writing assignment called, “What Causes Sound?” was used in a first-grade class. A fourth-grade student’s ELA writing paragraph started with this hook, “I bet you I can light a lightbulb and you can’t because I know a secret.” It continued later to reveal the “secret,” “The secret is you touch the first wire at the bottom of the light bulb then the second wire put it on the bulb casing and it will light up.” The student’s supporting illustration very clearly showed correct contact points on a battery and a lightbulb, a detail often missed. Thinking through how to clearly describe the D-cell and bulb contact points in writing supports the complex endeavor of using clear and concise language to convey a message.

As a result of access to high quality materials, professional development, and opportunities to creatively increase science instructional time and ELA connections, 98% of teachers report students engaging in collaborative science conversation at least once per week, and 98% reported high levels of student collaboration, especially with English language learners. At K–2, students in grant teachers’ classrooms outperformed other classes at their site on DIBELS, a reading measurement. Growth in DIBELS is demonstrated in 73% of these classes. This growth occurred after
a FOSS module was implemented. One participating second-grade teacher said, “Even my struggling students participate and share amazing perspectives. I never would have seen this side of their intelligence.”

**Transformation 3: Student-Centered Use of Science and Engineering Practices (SEP)**

During the first year, we saw evidence of teachers gaining understanding of how to support students in asking questions (SEP1) and planning and carrying out investigations (SEP3). This required teachers to work on “saying less” and listening to student as they came up with questions and collaboratively engaged in planning and carrying out investigations. By allowing students time and space to explore and develop their ideas, we found that students could figure things out and often had novel approaches to investigating a phenomenon. These observations led teachers to “trust” that students had the capacity to do the science using the same practices scientists use.

In year two, teachers began to think more deeply about how student science ideas developed and changed in light of the data they collected. Teachers applied their increased confidence and skill of facilitating student-centered planning and carrying out investigations to think about how to support students in their efforts to make sense of the data they collected while investigating. This led us to learning about how to conduct class discussions that resulted in students using evidence from their investigation to make claims to explain the phenomenon under study. As a result of practicing how to orchestrate these discussions, which came to be known as “talk circles,” students were presenting claims and supporting their claims with evidence (SEP6). Through this pedagogical approach teachers were supporting students in gaining abilities to do the practice of engaging in argument from evidence (SEP7) as well. In Alicia Vannatter’s sixth-grade classroom, students began requesting “talk circle” time to help them think critically about a phenomenon. According to Vannatter, “We were working through some content and it was getting tough. I had a student (who is not one of my high achievers, but she tries) ask, ‘Are we going to meet in a talk circle?’ I then responded, ‘Do you think that would help?’ And she was super happy to reply, ‘Yes, please.’” The next thing Vannatter knew, students asked if they could make meaning in this way during language arts class.

**What Professional Learning Components Led to These Dramatic Transformations in Just Two Years?**

These transformations can be attributed to dedicated teachers who were provided a significant amount of professional development spread out over three years. The content and pedagogy developed through our carefully facilitated learning program consisted of three days of learning the content and pedagogy for teaching a FOSS module, paired with five days focused on the Disciplinary Core Ideas with science professors each year of the grant. Additionally, we provided follow-up support and coaching during the school year. The program design includes teachers teaching the FOSS physical science modules in their classrooms during one trimester of the school year at grades K–5 and teaching Weather and Water for one full semester at grade 6 with individual real-time, side-by-side coaching. Two FOSS

Leadership Study Groups also allowed teachers to share ideas and expand their three-dimensional learning tools.

Over the course of the grant period, we expect teachers to reach the following learning outcome goals.

- Increased understanding of the characteristics of classroom lessons that exemplify Next Generation Science Standards-based teaching and learning that is accessible to all students
- Increased content knowledge
- Increased understanding and use of effective science teaching pedagogies
- Increased understanding and use of formative assessment
- Increased understanding and use of teaching strategies that integrate science learning with ELA and STEM

**Lessons Learned**

Teachers embraced teaching science when supported by FOSS modules, coaching, and professional development in NGSS and foundational science content. Modeling of strong pedagogical techniques allowed teachers to learn how to support student learning. Collaboration with other teachers gave grant participants support to explore the use of formative assessment as an instructional technique. All this work pays off as teachers hear students say, “I LOVE science!”
One warm morning as my husband and I sat on our front porch, we heard an odd, loud, piercing cry. Soon a medium-sized hawk flew to the top of the house across the street. We could see that it had a robin-sized bird in its talons. We watched the gory and fascinating scene as the hawk ate the slightly smaller bird. It was hard to look away, but I decided I had to try to get my camera to capture the moment. Of course, as soon as I went inside the hawk flew away. Despite having watched for a good minute or two, I don’t think I could confidently identify either the hawk or its breakfast. What could I have done differently to better remember the details of this experience and identify both birds? What tools would have been great to have at my fingertips?

John Muir Laws, a naturalist and environmental educator (he is named after but not related to John Muir, environmental advocate and founder of the Sierra Club), would have been prepared for the hawk and its hearty breakfast. He would have had his nature satchel nearby filled with his journal and the tools he needed to remember this experience; instead of going inside for his camera he would have known what to do to “capture” the moment forever. John, also known as “Jack,” has spent his career looking for the best tools to connect people to nature in order to help them fall in love with the world around them. He has dedicated his life to the art of nature journaling and to offering step-by-step guidance to help students and adults feel confident getting started.

In the following pages you will learn some of his basics of nature journaling, some techniques and tools to help you get started (or improve your experience) with students, and more about what has inspired Jack to do this work. We will also explore why this is important to do with students and you may just be inspired to do this on your own during your non-teaching time. At the end of the article we will include links to resources that you may enjoy.

**Fundamental Thinking Tool**

Laws argues that the observation notebook is a “fundamental thinking tool” that helps students observe more carefully and remember more effectively. He says, “Keeping a journal of your [nature] observations, questions, and reflections will enrich your experiences and develop gratitude, reverence, and the skills of a naturalist. The goal of nature journaling is not to create a portfolio of pretty pictures but to develop a tool to help you see, wonder, and remember your experiences.” He believes that all are capable of developing these observation skills and that you do not have to be either an artist or a naturalist to do this.

He continues,

> I believe that the process of attention is what makes you fall in love with the world. It is through attention that we create memories, but those memories will change over time so keeping a notebook and documenting what you’re seeing is a very powerful way to help you preserve the integrity of those memories as a scientist… the notes are data, a record of what I see.

During an interview with Jack, it became very clear that this passion of his would benefit FOSS users by helping teachers better support students with their science notebooks and would also help enrich many of the outdoor experiences built into our program. As you read this article, consider how these observation skills could be used both outdoors to help you dig a little deeper into the schoolyard activities in your Investigation Guides as well as with using science notebooks with students as they do scientific drawings with the classroom living organisms.
What Is Nature Journaling?
Observation notebooks, nature journals, science notebooks—Jack calls them nature journals, you can call them whatever you want—are all about getting students outside regularly to record what they see, to look very carefully at unique and mundane things they find and discover outside the classroom, and to slow down and connect with the natural world. Observations lead to deeper understanding and more lasting connections. Jack believes the step-by-step strategies used to enhance observations are tools that provide a road map to make stronger, longer-lasting memories, but also can help people connect more deeply with nature. Jack says, “Looking hard isn’t enough. Observation isn’t something in the eyes, it engages your brain in a dynamic way to remember what you observe—intentionally engage your curiosity. Curiosity is a skill you can enhance and develop if you’re deliberate about it.”

Getting Started
It’s probably best to start observing things that will not fly, hop, or run away. Start with acorns, seeds, leaves, or flowers. When you do want to capture an animal, they tend not to stay still for you or your students, so Jack recommends speaking out loud about what you see. As an example, the following is what I could have said about my hawk. (I will write an X when I cannot remember specific details),

The hawk is about 28 cm high, brown with only a few white feathers on the back, the white feathers look like stripes, its beak is X color, with a sharp point, the beak is about the size of X, the eyes are X color and located on the X of its head. Its tail feathers are X long. Its head swivels to the left and right about 180 degrees. It is resting on the peak of Sean and Carol’s house with a small bird in its talons. What is it using to balance itself if the bird is in its talons? I wonder how long it will take to eat the bird? What parts of the bird will it eat? Will it use the feathers for something else?

Saying these things out loud is a “powerful brain trick” and would have helped me form a picture in my head and in turn remember the details longer. Jack recommends thinking about patterns, shapes, sizes, etc. When the bird flew away, I would better remember as I pulled out my notebook from my satchel to start my nature journal. With a class of students, everyone would be whispering their observations at the same time to themselves. This can be practiced indoors and may seem silly at first, but it works.

The nature journal entry will be a conversation between a natural phenomenon and your brain. This process creates a time to slow down and process things. Jack recommends that teachers emphasize three languages in nature journaling: written, visual, and math. Of course, these would look very different with younger kids compared to older kids, but you will be the judge of what your kids can handle.

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Nature Journaling continued

**Written form:** Record short thoughts, ideas (no need for full sentences or correct spelling). Write what you see, hear, feel, wonder about, and any questions you have. Also, include the location, weather, and time of day.

**Visual:** Include drawings, diagrams, maps and sketches (color is not necessary, but useful). For drawings, start with the general shape and proportions of what you see and add details from there.

**Math:** Use the language of numbers. Count, estimate (especially when the numbers are too difficult to count), measure, and note the temperature. Record the time and date.

**Expert Teaching Tips and Tools**

Jack believes that the tools you include will influence how students observe and will affect the things students see. Students need easy access to simple tools when they’re on a nature walk, in the schoolyard, or on a field trip to a natural place. First, you don’t want to have to go inside to get something you forget (because the hawk will fly away!), and you also don’t want everything in a backpack, or in the teacher’s bag, because it takes too long to take it off or dig it out. Students need immediate access to their tools. Cloth shoulder satchels are ideal (Jack’s website, listed in Resources below, has some inexpensive recommendations), but if you’re like most teachers and don’t have a budget for something like this, consider making satchels for students using zip bags as FOSS describes in the Taking FOSS Outdoors chapter. Students would benefit from a small ruler, a magnifying lens, pencils, and of course, a notebook. The tools you have will change the way you observe—the tools you have affect the things you see. He cautions that the first time you introduce a new tool or a new procedure, it will be a novelty for students and may be a distraction. Students will want to investigate that new tool and use or do it regularly. Anticipating that this will be an issue for students will best prepare the teacher to expect certain behaviors.

The first time you do some nature journaling with students, the experience itself will be a novelty and a distraction. Likewise, taking students outside for an outdoor activity for the first time will also be a novel experience. In the Taking FOSS Outdoors chapter in FOSS Teacher Resources (also available for download on FOSSweb), we highlight many teaching strategies to improve the outdoor experience. We suggest a “sacrificial first lesson” knowing that students may break the rules in the outdoor space the first time. Jack thinks of this like the first “sacrificial pancakes” he makes for his kids. Daddy gets to eat those first few that don’t come out well. You cannot get into positive nature journaling experiences without those first less-than-perfect outings. Students will want to do it again and again and will quickly learn the behavior expectations and how to use the tools.

**Why Should People Nature Journal!**

According to Jack,

People should do this because the world is infinitely fascinating and beautiful. You see so much more when observing through the journal. The ability to hold things in our head is really limited. Journaling gets us past the limits of our brain’s capacity of how much information it can store and hold and manipulate at one time. The journal frees up our brain, once you’ve got all of this down on paper, your brain is freed up to operate at more sophisticated levels.

Nature journaling can also be a great way to reach out to children. As Jack explains, “I was shut down academically and had come to believe, because I’m dyslexic and had trouble spelling and writing sequences of numbers, that I was stupid.” But a high school biology teacher saw past this by engaging Jack, believing in him, and introducing him “to the joy and fun of scientific exploration.”

The FOSS staff work with educators from across the country and we know that many of you are meeting the young “Jacks” of the world and believing in them. You help them see the wonders of classroom science, the schoolyard, and the greater world around them. We believe that finding time to use nature journals with your students will make them more productive thinkers, better observers, and more peaceful nature-loving young people.

Jack is an advisor to the BEETLES™ (BetterEnvironmental Education Teaching, Learning and Expertise Sharing) program of the Lawrence Hall of Science where the FOSS Project is developed. Jack partnered with BEETLES to help create some of these teacher friendly videos and supports: beetlesproject.org/resources/

Be sure to visit and explore Jack’s personal site as well. www.johnmuirlaws.com
The Assessment Corner: Assessing the Three Dimensions of the NGSS
By Kathy Long, FOSS Assessment Coordinator, The Lawrence Hall of Science

The FOSS project developed its assessment system through an NSF-funded project ASK (Assessing Science Knowledge, 2003–2009). During that six-year project, we worked extensively with teachers in nine school districts and educational service areas to create what has now been embedded in FOSS Next Generation and Third Editions. Some of you may be asking, if those assessments were created before the NGSS existed, how can we use them for gathering three-dimensional data about our students’ performance? The ASK Project helped us to determine what were the most effective formats for assessment, and what pieces of a system worked best for teachers and students. The content for each assessment in the Next Generation and Third Editions has been updated to match the recommendations set forth in the National Research Council’s A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (2012) and the NGSS.

The diagram on the next page shows the basic structure of how the assessments have been designed into “sets” for the new editions. Not every assessment item assesses all three dimensions of NGSS, but we have done our best to make them at least two-dimensional, and given any one performance assessment or I-check you will find all three dimensions interwoven within the set of assessment items.

Performance assessments. These assessments occur generally once during each investigation. In earlier editions, we included performance assessments at the end of a module to be completed with the posttest. We’ve incorporated performance assessments strategically into the regular FOSS investigation sequence, so the investigations and performance assessments are one and the same. During these investigations we have provided specific information about which practices, core ideas, and crosscutting concepts are best assessed during the investigation. Performance assessments focus equally on practices, core ideas, and crosscutting concepts.

Embedded assessments. These formative assessments occur daily, (you could consider performance assessments a sub-category of embedded assessments). They include looking at students’ answers to focus questions, response sheets, and other notebook entries. These assessments focus mainly on the disciplinary core ideas—what sense are the students making of investigations that utilize practices and crosscutting concepts in order to build their science content knowledge. In the Assessment chapter of the Investigations Guide, there is a technique called the Reflective Assessment Practice that explains how to review a sample of student work in as little time as 10 minutes. The importance of this practice is to make students’ thinking visible on a regular basis in order for teachers to make informed decisions about their next steps in instruction and whether those next steps need to focus on practices, content, or crosscutting concepts.

Benchmark assessments. These assessments are composed of multiple-choice, multiple-answer, short-answer, and open-response items in typical test formats.

Chatting with a Young Nature Journaling Newcomer

Did you notice the nature journal pages in the article about John Muir Laws? These are from a journal by 13-year-old Fiona, a seventh-grader at Live Oak Waldorf School in Applegate, California. She has been doing this for only five months. We asked Fiona to tell us one magical experience she had in nature with a journal. Here is her reply.

In August, I was back in Sierra Valley with my new best friend and nature journaling buddy, John Muir Laws, also known as Jack. We worked in our journals and sketched the birds we saw, including American bittern, sandhill crane, and great egret. As we walked up to the steel bridge, it was dusk, and my mom called out “Barn owl! Barn owl!” and Jack and I saw it flying along the edge of the bridge. We were mesmerized. Then Jack said, “I just saw that barn owl fly under the end of the steel bridge.” We gave each other one look, and, since we are crazy nature people, we went running to the end of the bridge where he saw it go. Jack climbed down over the edge of the bridge and peered in under the large rock piles around the base of the bridge. It was almost dark by then, so Jack pointed a flashlight into a crevice in the rock pile. He looked up at me, and whispered excitedly “FIONA! You NEED to come down here RIGHT NOW!” So my mom and I climbed down and peeked in, and there, not two feet back in the hole, looking right at us, sat the spectacular barn owl. Of course, we both went straight to our journals to draw and write about it. This evening was a truly miraculous occurrence that I will never forget. ☀️

Continued on page 18
The items are designed to be two- or three-dimensional. These items are more content focused, but do include items that clearly assess practices and crosscutting concepts. The items are coded holistically, to assess the students' ability to integrate the disciplinary core ideas with science practices and recognize crosscutting concepts.

Benchmark assessments serve a dual purpose. They can be used to continue the formative assessment work of the embedded assessments, and we highly encourage this use for developing a classroom with a growth mindset. They can also be used for summative assessment, when grades are needed. If grades are given, we suggest that students still be given the opportunity to self-assess their work and improve their responses needed before a grade is assigned (see “The Assessment Corner,” FOSS Newsletter, Fall 2016, for more suggestions). These assessments, like the embedded assessments, provide diagnostic information for teachers as well as students, and give enough information to determine which dimension(s) needs more work.

Interim assessments. This is a new set of assessment items that we are currently developing. As various groups around the country have begun to develop “NGSS Three-Dimensional Assessments” mainly to anticipate the assessments that states will be developing, we have been keeping an eye on their work. What we generally see are item bundles being used to assess the three dimensions. There is a context-setting scenario to set the scene and describe a phenomenon for students to think about. Sometimes this scenario includes a short investigation to complete or an artifact for students to consider (such as a set of data, a graph, a video, or an online activity). Then there are items that focus on the dimensions of science learning in order to provide a three-dimensional look at student progress. For these assessments, we will try to tease apart the three dimensions of the NGSS.

Our plan is to create two interim assessments for each module, one that can be given halfway through a module and the other after instruction is completed. We will pilot these assessments for grades 3–5 in March 2017, then continue the process to include grades K–2 and middle school in the near future.

In summary, the FOSS assessment system is in step with the recommendations of various organizations calling for three-dimensional assessments. As more groups provide examples of these assessments, we will update our system as needed. Right now, we know we have a good system that is especially strong in formative assessment. As developers of a curriculum project, not developers of state assessments, formative assessment is the most important place for us to focus. This ensures that teachers and students get the information they need on a timely basis to inform instruction and continuously improve student learning.

A note about FOSSmap: We want to thank all of you who have logged onto FOSSmap and are using the system! The good news is we’ve got lots of people using the system. The not so good news is that our original system is having a hard time keeping up with all the activity. In response, we are in the process of engaging a vendor that will be able to deliver these assessments on a system that will be much more robust. We know that the current system is causing some frustration, but hope you will continue to persevere and know that a much-improved system is on the horizon. We hope it will be up and running by August 2018, if not sooner. Stay tuned! 🌚.

For any FOSSmap technical questions or support, please email: support@fossweb.com.
FOSS Professional Development at NSTA: Fall 2017

Delta Education will host FOSS several Professional Development opportunities before the 2017 Fall NSTA Conferences (Baltimore, 10/4/17; Milwaukee, 11/10/17; New Orleans, 11/29/17). These Institutes will be for educators who plan to transition to FOSS Next Generation K–8. These Institutes are designed for lead teachers, administrators, curriculum developers, professional developers, and university methods instructors.

To get more information, please contact:
Jenn Reid Strong at Delta Education
800.338.5270 x3667
jenn.reid@schoolspecialty.com

Sign Up to Receive the FOSS Newsletter
To receive the FOSS Newsletter electronically, sign up at www.deltaeducation.com/FOSSnewsletter.

You can view the current and previous issues at http://www.FOSSweb.com/newsletter.

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Permanent Access Codes
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FOSS Middle School 1st Edition Access Code
AME1MS4600

AME1CA8460

FOSSweb Help
Account Questions/Help Logging In/Access Code Issues
School Specialty Science Technical Support
techsupport.science@schoolspecialty.com
Phone: 800.258.1302, 8:00 am–5:00 pm ET

General FOSSweb Technical Questions
FOSSweb Tech Support
support@fossweb.com

FOSS Registration Walkthrough Videos
http://tinyurl.com/pp2bw3v

http://www.facebook.com/FOSSscience
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Calendar of Events

NSTA NATIONAL CONFERENCE
Los Angeles, CA, March 30–April 2, 2017

Thursday, March 30
8:00–9:30 Engage Students in FOSS Next Generation K–8
10:00–11:30 Ten Minutes to Improving Science Achievement
12:00–1:30 Model Elementary Science Implementation
2:00–3:30 Wave Properties and Information Transfer
4:00–5:30 Evolutionary Evidence in the Fossil Record

Friday, March 31
8:00–9:30 What to Look for in Physical Science Learning Progressions—Experience FOSS K–5
10:00–11:30 What Does Argumentation Look Like in an Elementary Classroom?
12:00–1:30 What Does Conceptual Modeling Look Like in Grades K–5 Classrooms?
2:00–3:30 Developing Models for Sensory Receptors
4:00–5:30 Identifying Energy Transfers in Motors and Generators

The Lawrence Hall of Science Institutes for Leadership Educators
The Lawrence Hall of Science, Berkeley, CA

June 27–28, 2017; repeated on June 29–30
FOSS Next Generation New User Institute (K–5)

July 6–7, 2017
FOSS Partnerships for Professional Learning

July 11–12, 2017
Electromagnetic Force: Next Generation Course (6–8)

July 13–14, 2017
Gravity and Kinetic Energy: Next Generation Course (recommended for grade 8)

July 17–18, 2017
Waves: Next Generation Course (recommended for grade 8)

July 19–20, 2017
Hereditity and Adaptation: Next Generation Course (recommended for grade 8)

July 25, 2017
FOSS Next Generation and the CA framework (for CA users)

July 26, 2017
Integrating the curriculum with FOSS Next Generation (for CA users)

July 27, 2017
FOSS Next Generation Assessment (for CA users)
FOSS Next Generation Conversion Options are Here!

Delta Education now offers new ways to convert your previous editions of FOSS to FOSS Next Generation to help meet your logistical and budget needs!

- Program-level conversion plans: Collaborate with Delta to move your existing equipment around to create the Next Generation kits and order the specific equipment and print you need to make them complete.
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Read more about converting to FOSS Next Generation here: deltaeducation.com/NGupgrade

Delta FOSS Sales and Marketing Division
800.258.1302
603.889.8899
Robert “Brian” Gossage
Sales Manager, Eastern U.S.
robert.gossage@schoolspecialty.com
Joe Weisbecker
Sales Manager, Western U.S.
joeweisbecker@schoolspecialty.com
Karen Stevens
Director, Marketing
karen.stevens@schoolspecialty.com
Kevin Smith
Director, Sales Support
kevin.smith@schoolspecialty.com
Jennifer Apt
Product Development Manager
jennifer.apt@schoolspecialty.com
Jenn Reid Strong
Institute Coordinator
jenn.reid@schoolspecialty.com

FOSS Regional Sales Managers
All Regional Managers have toll-free voice mail at 800.338.5270

Kip Bisignano
DC, Eastern NC, MD, VA, WV
614.406.2982
kip.bisignano@schoolspecialty.com

Susan Hardy
FL, GA, Western NC, SC
770.296.9286
susan.hardy@schoolspecialty.com

Verne Isbell
AR, LA, OK, TX
817.239.4493
verne.isbell@schoolspecialty.com

Jacob Kane
CT, NY
585.354.6888
jacob.kane@schoolspecialty.com

Bjorn Larson
IA, MN, MO, ND, SD
651.895.3000
bjorn.larson@schoolspecialty.com

Elizabeth Mijal
International Sales
603.566.8311
elizabeth.mijal@schoolspecialty.com

Karen Moore
AK, ID, MT, OR, WA
206.841.6124
karen.moore@schoolspecialty.com

Chika Onyeani
DE, NJ, NY City
609.472.2853
chika.onyeani@schoolspecialty.com

Maggie Ostler
UT, HI, Central CA
949.275.2602
margaret.ostler@schoolspecialty.com

Richard Pacheco
AZ, NV, Northern and Southern CA
602.750.0615
richard.pacheco@schoolspecialty.com

Diana Partyka
MA, ME, NH, RI, VT
617.549.6590
diana.partyka@schoolspecialty.com

Eileen Patrick
CO, KS, NE, NM, WY
303.548.2767
eileen.patrick@schoolspecialty.com

Kathleen Schutter
KY, MI, OH
859.404.3870
kathleenschutter@schoolspecialty.com

Dean Van Order
IL, IN, WI
715.540.0646
dean.vanorder@schoolspecialty.com

Meredith Wells
AL, MS, TN
864.978.7560
meredith.wells@schoolspecialty.com

Dawn Wilson
PA
610.767.7163
dawn.wilson@schoolspecialty.com