Linking Science, Inquiry and Language Literacy

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Reflections from L-SILL Schools

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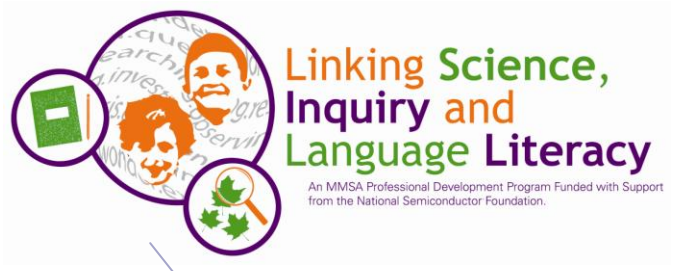
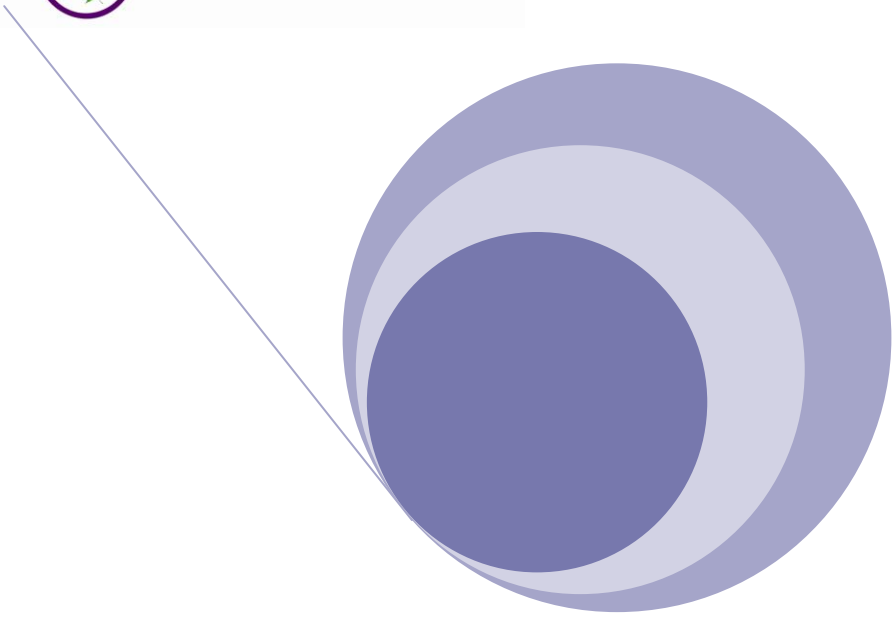
Maine MATHEMATICS and SCIENCE Alliance





Reflections from L-SILL Schools

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Nancy Chesley and Lynn Farrin: Editors

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A person who never made a mistake never tried anything new.
– Albert Einstein

From the editors' desk

L-SILL connects inquiry science and language literacy in a way that is appealing to elementary educators. Supporting science with writing, reading, and language allows them to build on their strengths in the language arts as they strive to provide effective science instruction for their students. However, this innovative approach requires educators to step out of their comfort zone and necessitates a new perspective for elementary science. Their evolving ideas about engaging students in science included challenges that required perseverance and dedication.

Carl Sagan once said, "Science is a way of thinking much more than it is a body of knowledge." As we read through the essays for this collection, we realized that the educators involved in the L-SILL project emerged from their experience with more than a body of knowledge about the science-literacy connection. They emerged with a unique way of thinking about their approach to teaching science and about the students they teach. Their voices resonate with phrases like *moment of pride, clearly enriched, level of confidence, real scientists, rewarding experience,* and *greater ownership.* Their voices speak to hope about the future of elementary science, to perseverance in the face of uncertainty, for commitment to Maine's youngest students, to the pursuit of an equal opportunity for all students to pursue science, and to pride in the students who have found joy and success in learning.

Educators in the L-SILL project learned the power of language arts to support science learning. The focus in science instruction for these teachers is on the science, not on decoding words, the specifics of grammar, punctuation, or spelling in the students' writing, but on the evolving understanding of students as they record their journey through an investigation, noting instances when their thinking has changed and why that change happened. Students who find reading and writing difficult and intimidating in their language arts instructional block enthusiastically immerse themselves in the written and spoken word as they question, explore, predict, and investigate science phenomena.

As you read these stories, we hope you will find inspiration in the words of your Maine colleagues. We want to thank all the educators in the project who dedicated their time, talent, expertise, insight, and energy to the L-SILL vision and to Maine students.

We invite readers of these essays, submitted by selected L-SILL educators, to imagine the excitement of students, teachers, administrators, and parents alike as children engage in authentic science learning, not for a grade or reward, but for sheer excitement as they make new discoveries about the world around them and beyond.

Editors

Lynn Farrin and Nancy Chesley

I am often amazed at how much more capability and enthusiasm for science there is among elementary school youngsters than among college students. – Carl Sagan

Introduction

We are pleased to share with you this collection of essays that highlights the learnings and lasting impacts of the Linking Science, Inquiry, and Language Literacy (L-SILL) project. A multi-year (2005-2011) initiative of the Maine Mathematics and Science Alliance (MSSA) funded by the National Semiconductor Foundation, L-SILL's goal is on improving student achievement in science by supporting elementary teachers as they learn and implement strategies that link reading, writing, and speaking to inquiry-based science.

Developed in response to a growing national concern that instructional time and student opportunities to learn elementary science have decreased in recent years so that more time can be spent to increase achievement in reading and mathematics, the L-SILL project synthesizes practices from several successful NSF-funded initiatives and other efforts that have shown quite the opposite – providing time every day for high quality science instruction coupled with content literacy skills not only improves student achievement in science, but in reading and writing as well. Science provides a rich and engaging context for students to practice and authentically use content literacy skills. The project also addresses the need to develop expertise among elementary teachers, many of whom have emerged as influential leaders guiding lasting change in science education at the school and district level. As you will read in this monograph, Maine teachers and administrators share their experiences and new understanding of practices that engage students in the application of language arts while developing an understanding of essential concepts in science. In this strategic coupling of inquiry-based science with reading, writing, and speaking, students receive a double dose of language literacy processes. Changes are evident in the way teachers think about science inquiry and the implementation of a key science-literacy strategy, scientists' notebooks, in these writings.

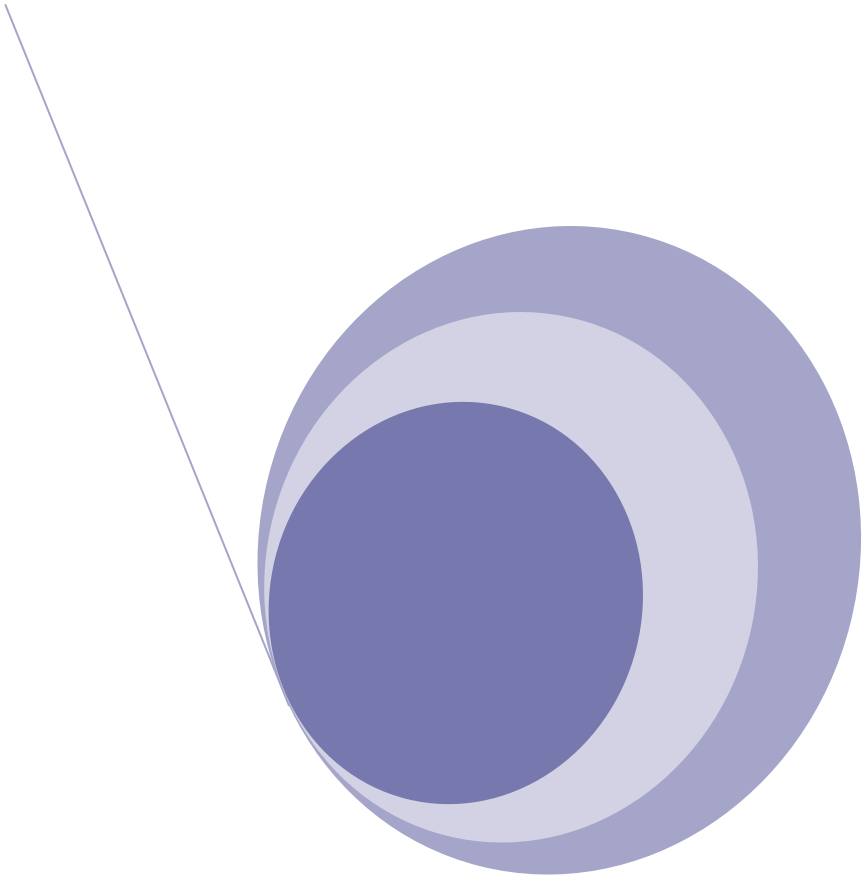
National projects that guide and inform the L-SILL work are: Valle Imperial Project in Science (VIPS); Connecting Science and Literacy Project (CSLP), Education Development Center (EDC), Newton, MA; Writing in Science Project, Seattle Public Schools; Seeds of Science and Roots of Reading, University of California, Berkley and Lawrence Hall of Science.

Schools from across Maine were selected for the L-SILL project based on a number of criteria: limited access to resources for improving science education such as hands-on materials, local expertise, and funding for science programs; low student performance as indicated state and district test results in

science and/or in reading and writing; geographic isolation and a desire to collaborate with other schools; teachers with limited professional development in science; and/or high need student populations defined by poverty level, percentage of minorities, and/or English as a second language. The Maine Department of Education also recognized the successful efforts of the L-SILL project and awarded supplemental funding, allowing MMSA to support an additional cohort of schools under its L-SILL Enhancement project.

Over the past six years, in addition to providing direct support for schools in the project, schools across Maine and New Hampshire have also benefitted from L-SILL in professional development events open to the public such as annual statewide conferences, online book studies and regional workshops.

These reflective writings give readers an intimate look at how teachers from across Maine transformed their teaching by making purposeful connections between science inquiry and language literacy. We hope you find their stories insightful and inspiring. - *Lynn Farrin and Nancy Chesley*



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Follow effective action with quiet reflection. From the quiet reflection will come even more effective action.
- Peter F. Drucker

Durham Community School is a K-8 school of 420 students located in central southern Maine. It opened in 2010 and replaced the old Durham Elementary School. The school is a state of the art facility with an emphasis on energy efficiency and sustainability.

Implementing school wide reform in science education: One school's story

by Will Pidden

Will Pidden is the principal at Durham Community School, a K-8 school in Durham, Maine. Will developed a vision for improving science education and led his L-SILL team and staff through the multistep process of linking science, inquiry, and language literacy and providing quality science instruction for Durham students.

How can an outside organization support effective curriculum and instructional change in a school? The L-SILL grant funded by National Semiconductor and implemented by the Maine Mathematics and Science Alliance (MMSA) demonstrated just how it can be done by balancing hands-off sponsorship, hands-on support and a focus on local ownership.

Durham Community School is a K-8 school of 420 students located in central southern Maine. Under pressure to increase literacy skills, the science curriculum had been diluted in the lower grades over the last ten years. While the school's 8th graders continued to do well on Maine state assessments, there was a concern that the essential problem solving skills and applied thinking of inquiry based science were getting lost.

The three main areas of focus for the school was to develop a balanced K-8 curriculum for science, implement the use of scientists' notebooks and increase students' "science talk." All under the auspices of inquiry based learning.

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Once our school had been accepted into the L-SILL project, we established a team consisting of a teacher from each of our grade clusters, K-2, 3-4, 5-6 and 7-8 along with the principal. The process of curriculum development began with the support of Lynn Farrin from MMSA. She patiently walked our team through the various science standards that range from the *Maine Learning Results* to the various national science standards proposed by the National Research Council (NRC) and the American Association for the Advancement of Science (AAAS). The desire of our team was to just adopt whatever "program" Lynn felt was best, but she guided us towards developing a scope and sequence that related to our school and that would be sustainable. This was a key step, as ownership of the curriculum is essential in any improvement efforts. Without it there is the tendency to "blame" the

curriculum or the "decision maker" when things are not going well rather than solve the problem.

The team determined that the curriculum should contain skills and content in life science, earth science and physical science at each grade level. Beginning with a review of our current curriculum and the range of skills and content required, we found there were extensive gaps in physical science concepts at the lower grade levels. The team also identified with their teaching colleagues the units they currently taught which they considered most effective and those which were most in need of improvement or replacement. The outcome of the curriculum work was a K-8 matrix that represented the essential components for science content across life, physical and earth science. Each unit would contain links to literacy and be inquiry based.

When it became time to put substance around the matrix we decided to review different publishers' science "kits" as well as refine some of our own units. In discussions with other L-SIll schools we decided that no one publisher had a lock on the best science units and instead decided to pick and choose from the variety of options to best meet our needs. These considerations included quality of literacy support, clarity of science concepts, cost, length of unit and especially, demands upon teacher preparation.

Incorporating literacy into science was the second key component of our improvement efforts. Nancy Chesley, from MMSA, led this work initially as she provided staff professional development on how to utilize books and literature as ways to put the content into a context and as well as how to relate it to real life. The literature also provided sources of research information in the form of non-fiction books. Another aspect of literacy work within the L-Sill initiative is the use of scientists' notebooks. This was a shift in thinking for a number of us as the emphasis went from just recording the inquiry-based investigation process in the notebook to also recording the students' thinking and evolving understanding of essential science concepts.

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In an inquiry based model this is a crucial step as the notebook provides the springboard to broader conversations and follow up experimentation. Just as with the curriculum we found that there was no one "notebook" published that met our specific needs and we are now in the process of finalizing our own notebook expectations. These non-negotiables will provide a notebook experience that spirals up through the grade levels, increasing demands that culminate in the 8th grade in a more formal science lab report that

Incorporating literacy into science was the second key component of our improvement efforts.

also contains the essential components of thinking and questioning based on student generated data and evidence.

Science talk was the third component of our improvement efforts. This has been one of the most transferrable skills from and to other content as we had previously worked with our students on talking as readers and writers. The missing ingredient in our science talk, though, had been data or evidence. As with the lab reports, the previous focus had been on just what happened. Science talk has shifted our work to more purposeful, informative conversation: "What is happening? How do we know? Why do we think it is happening? What do we think will happen next? Where is the evidence?" Science talk has perhaps been the most noticeable shift in our practice. It is truly inspiring to walk around the classroom listening in on children discussing their thinking, wrestling out loud with tough concepts and challenging previous assumptions.

Science talk was the third component of our improvement efforts.

Not only have students enjoyed the difference in their science work, but parents also have seen a difference in the way children are working, as Jen Galletta noted in a school newsletter after volunteering in her daughter's 1st grade classroom.

You start with a mountain of recycled materials and you end up with a musical instrument. I really didn't think this was actually going to happen, not to mention in less than an hour.

As the first graders were culminating their study of sound in their science classes the focus of this inquiry based work turned to application. In particular what variables impact volume and pitch.

I arrived in Miss Morse's classroom as she began to give directions to the first graders. Each student had already drawn a sketch of the instrument they intended to make, but actually producing them was about to start. In addition to just creating the instrument, it was expected that each one could produce both low and high pitches as well as increase and decrease in volume.

Each student was eager to be called to the "mountain" and find the necessary items to make their instrument. From boxes of all sizes, paper towel rolls, plastic jars, string, beans, fishing line to tape; if you needed it, it was there. Each student was genuinely focused on creating his or her own masterpiece. As I walked around offering assistance, I was impressed with the drawings of the instruments, but really questioned if they would come to fruition. As the instruments started to take shape, my question was answered. Not only were these students creating working instruments, they were thinking "out of the box" and not following the traditional rules of certain instruments. Who knew guitar strings could attach to so many different places on the guitar

and create several different pitches by doing it? As I continued walking around, students were explaining to me how their instrument had low pitches by doing this or high pitches by doing that and how they could increase the volume by doing this. I also learned that first graders really love to increase the volume, on anything!

How can an outside organization support effective curriculum and instructional change in school? National Semiconductor provided essential funding to a recognized and respected educational support network in the Maine Mathematics and Science Alliance and let them get on with it. MMSA then wrote specific and targeted goals and found committed parties looking to improve science knowledge and skills of their students. MMSA provided ongoing support but let the individual schools lead their own process. In essence they let us get on with it. The school, in turn, followed the same path. Provide children with authentic, inquiry based science classes and let them get on with it.

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Students making musical instruments

Scientists' notebooks: What are they and why use them?

by Tina Whalen

Tina began her career in Hinesburg, Vermont teaching math and reading in grades 7/8 and then in a 5-6 multiage classroom. She then taught in Falmouth, Maine, grades 4 and 5. She currently teaches grade 4 in Durham, Maine.

Why scientists' notebooks? How is a scientist's notebook different from using a workbook that accompanies a kit?

Why scientists' notebooks? How is a scientist's notebook different from using a workbook that accompanies a kit? How does it impact scientific inquiry? I had become quite comfortable with teaching the traditional scientific method. Why would entering the information discovered during a lab procedure be any more valid or reliable if it were recorded in a notebook? After joining my school's LSILL team three years into its inception, these were the initial questions that applied directly to my 4th grade classroom teaching, but the answers would develop and continue to grow, as I spent the year in a full-speed-ahead crash course about how science education was changing in our elementary school classrooms. Who knew that while I took six years off to raise my young children, a collaboration would be taking place across Maine schools to align scientific thinking across the grade level spans?

Teaching science has been a great passion of mine. It is a true opportunity to see students come alive: hands-on engagement, developing questions, seeking answers, and igniting curiosity. When my teaching career began in rural Hinesburg, Vermont, developing science units and the individual lessons was time consuming, but fun. It consisted of reading for information, research, field trips to local marshes, demonstrations using coffee filters to separate individual pigments from black marker, and using recycled materials to make sea creatures with special adaptations. Using the conventional scientific method with a template-style worksheet was customary and innovative at the time. I was proud of my students when they had become so used to its format as to be able to recite the steps: ask a question, develop a hypothesis, list materials, make observations with illustrations, and draw a conclusion. It was a recipe for science and, if followed, could be a catalyst for true inquiry; or so I thought. The only problem with the rigidity of that type of then-current thinking was that true curiosity isn't a recipe. A scientist doesn't follow a recipe- she wonders, reasons, predicts, uses findings from other valid experiments to inform and to develop new questions. During our school's L-SILL meetings, I was able to see how, if children are shown incrementally how to investigate their own scientific inquiries, they would be led to take their next steps with the guidance of

the teacher, rather than at the request of the teacher. I was eager to see if my fourth grade students felt a sense of ownership of their scientists' notebooks and if this ownership led to a hunger for inquiry and investigation.

Inquiry, coupled with a scientist's notebook, provides a consistent framework to engage students in science investigations. But a science investigation is only as good as its investigative question. Take, for example, questions designed by two of my students, who each wanted to find out if different parts of their tongue tasted foods differently. How can we find out the ways that the tongue tastes food?" The question posed to the whole class brought an onslaught of ideas, none of them alone able to lead us to a well-designed experiment, but together, served as pillars to a bigger, well-designed question that could be tested. It led to a broader question thought of by another classmate, "Do different parts of the tongue taste foods differently?" While this is a great question, we needed to tweak the inquiry so as not to seek out a yes or no answer. "How do different parts of the tongue taste foods?" was more open-ended and would allow for a variety of explorations and subsequent explanations. With the help of my L-SILL team, I was able to come up with a series of question starters that were appropriate for the fourth grade. In my classroom, students learned that "How can we find out" questions are great prompts to well-designed explorations.

Students record the question in their scientists' notebooks and use it as a springboard toward designing an investigation. For example, one student suggested we should dip our entire tongue in a cup of lemon juice to see which parts of the tongue taste it the strongest. Another student suggested putting a drop of juice on the center of the tongue and letting it spread out over the tongue. While both of these would have been fun to try, my prior discussions with my school's L-SILL team led me to believe that the students would have come to a conclusion that satisfied their prediction and the results would have demonstrated their eagerness to be correct rather than to be accurate. It is this bias toward an answer that satisfies their prediction that is so typical of a fourth grader, and it's why the teacher often needs to step in and guide them toward a possible strategy to explore the inquiry. As a class, we developed a procedure to find out the ways the tongue tastes food, and then I posed some possible data collection methods and polled the class as to which one seemed to be the best fit. An important point made during an L-SILL professional development workshop guided me during my facilitation: Guide the students to think like scientists by asking questions that probe. For example, when a student suggested we dip our entire tongues in a cup of sour solution, I asked her, "When you experience the flavor of a pickle, does your sense of tasting sour come from only one side of your tongue?"This prompted her to suggest that we

should see if different parts of the tongue are responsible for detecting different flavors.

At this point, students had used their scientists' notebooks to record an inquiry question, a procedure, a prediction and a data collection method. We just needed a list of materials. Students eagerly offered to bring in cotton swabs, cups, lemon juice, salt, and sugar for our investigation. Before they even took off their backpacks, they stood before me individually, proudly holding up their contribution. The excitement around this level of participation prompted me to take note that while ready-made science kits are convenient, I should be careful not to imply to my students that science tools come in a big blue tote.

Professionally, the real discovery for me had been made as I tried to see why using scientists' notebooks was a better choice for student learning than rigidly following the workbooks that accompany traditional science kits.

While the investigation proved exciting and engaged all the senses, it was important to keep bringing the students back to the fact that because we are trying to isolate flavors in regions of the tongue, it is imperative that they not draw their tongue back into their mouths, which would distribute the solution over their entire mouths. Another key point that I had remembered from L-SILL discussions was to keep students engaged with their scientists' notebooks, recording data and taking notes about questions that arise during their exploration. It is common for fourth graders to become so involved in the process that they forget to record all of their observations and specific data.

The importance of the scientists' notebooks surfaces during our class discussions that follow our investigations. "How did your results compare with your prediction?" "What questions came up during the procedure?" "What can you conclude from the data?" "What would you do next to further your investigation?" As these questions were answered, I could see the students lighting up with excitement as they shared similarities about what they discovered, unearthed mistakes they had made while collecting data or doing the procedure, and most profoundly, thought up new investigative questions to further research. I could see with questions such as, "What would happen if we mixed two flavors together and tested it on each others' tongues?" that students were engaged in the process of discovery and data collection and that real seeds of science had been planted.

Professionally, the real discovery for me had been made as I tried to see why using scientists' notebooks was a better choice for student learning than rigidly following the workbooks that accompany traditional science kits. While the workbooks were thorough and organized, taught direction

following, and exemplified a variety of data collection templates, they proved to be too much of a roadmap that students follow, causing them to keep their eyes on the map rather than enjoying the discoveries that can be made along the route - which is a more genuine way of developing creative and scientific thinking. The ownership students felt as they looked over their notebooks at the end of the year and noticed how much better they became at organizing their data was a priceless moment of pride for all of us. It is clear that we are onto something as students learn that procedures, accuracy, testing, and recording data are paramount to true inquiry and using their very own scientists' notebooks is a reference tool they have created themselves.

The ownership students felt as they looked over their notebooks at the end of the year and noticed how much better they became at organizing their data was a priceless moment of pride for all of us.

And time for reflection with colleagues is for me a lifesaver; it is not just a nice thing to do if you have the time. It is the only way you can survive. - Margaret J. Wheatley

Shapleigh School is comprised of grades 4-8 with an enrollment of approximately 400 students. Kittery is a diverse community and school district located in the southernmost part of Maine.

Mysteries and more

by Corrine Gagnon

Corrine Gagnon taught science in grades 4 and 8 at Shapleigh School in Kittery, ME. She was a fellow in the 3rd Governor's Academy for Science and Mathematics Leadership. Corrine applied the science-literacy connection by combining science investigations derived from short mystery stories, scientists' notebooks, inquiry boards, graphic organizers, and picture books to frame her science instruction.

Science is valued more now as a content area thanks to L-SILL, and science-literacy connections are being made.

Science is valued more now as a content area thanks to L-SILL, and science-literacy connections are being made. Collaborating with colleagues to apply for participation in the Linking Science, Inquiry, and Literacy (L-SILL) project was a unique opportunity. This was my first experience with proposal writing. As a new teacher I was learning the ropes and as far as teaching science, all I had was boxes of photocopied sheets left behind from a teacher that retired. I appreciated the materials but felt overwhelmed. I did not know where to begin, what was important to teach, or how to go about teaching what was on these pages of paper. I felt like I was in the middle of a science mystery.

Opening the letter from the Maine Mathematics and Science Alliance (MMSA) in the spring of 2008 was an exciting moment. Were we accepted as a teaching team into the L-SILL project or not? I was scared to open the letter. I looked forward to the opportunities that would come my way as a member of the L-SILL team if we were accepted into the grant program. There was nothing to be lost if our school was not chosen but much to be gained if it was. The good news came in that letter, and this was the start of our three- year adventure.

During the first year of the program, my colleagues and I began to build relationships with staff at MMSA. We participated in several professional development opportunities and were given support in looking at our curriculum and funding to support change in science instruction. Working in a district with limited funds, these opportunities greatly enhanced science education at the elementary level.

Scientists' notebooks and the consistent use of them prompted the first changes I incorporated into teaching science.

Scientists' notebooks and the consistent use of them prompted the first changes I incorporated into teaching science. In the past I had used booklets for students to keep notes but did not have one specific type of notebook that was used throughout the year. Scientists' notebooks gave students a place to be "real scientists," a place to take notes, collect data, make observations, and

sketch or draw what they see. The use of these notebooks began to bring consistency to the teaching of science between grade levels and is a great way to make a science-literacy connection.

The teaching of inquiry-based science lessons along with making science-literacy connections impacted my teaching. I participated in an online workshop based on the book, *Everyday Science Mysteries*, by Richard Konicek-Moran. This workshop provided a professional development opportunity for me to collaborate with other elementary science teachers across the state. The mysteries in the book are a great way to engage students in inquiry-based science. The stories provide real life scenarios that encourage students to ask questions and seeking the answers through science investigations. By asking questions, students begin to see the connection between science at school and what scientists do as a profession.

Inquiry boards are great tools to help students set up scientific investigations. These boards help identify variables and provide an opportunity to scaffold instruction in order to meet student needs.

By using *Everyday Science Mysteries*, students set up investigations, make predictions, make observations, collect and analyze data and write conclusions in their notebooks. By keeping all of their information in one location, students can go back and look at previous work they have done. This involves students in making science-literacy connections. They can assess their own work and learn from each other through class discussions. The mysteries provide students with an opportunity to investigate different questions, giving them a sense of ownership over their work.

Inquiry boards are great tools to help students set up scientific investigations. These boards help identify variables and provide an opportunity to scaffold instruction in order to meet student needs. Over time, students begin to take more ownership in the inquiry process. It was through an L-SILL professional development site visit that I was introduced to the inquiry boards. MMSA staff took a group of teachers at my school through the process of making the boards and discussions took place around how to use them. Time is something in short supply for teachers. If I had not had the opportunity to participate in this session I might not have had time to make the boards on my own. Personally I have walked away from many professional development opportunities saying to myself, "That sounds great if I only had the time." My participation in the L-SILL project provided me with the time to learn new strategies for science instruction, collaborate with other professionals and participate in inquiry-based science. I learn by doing and had several opportunities to practice new ideas before taking them back to my classroom.

The L-SILL program has provided my district with valuable science resources. Dinah Zike's *Big Book of Books* provides unique ways to use graphic organizers in science. I have found this to be an effective way to engage students. They enjoy presenting information in unique ways. It has been a successful tool to use with reluctant writers. Students feel success. Graphic organizers found in the Dinah Zike resource books have brought life to writing in science and enhance the science-literacy connection. I have used several different organizers for data collection when doing investigations from the *Everyday Science Mysteries*.

Picture books have also become a valuable tool in teaching science. I never imagined I could use them in so many different ways. L-SILL exposed me to a variety of high quality books. I never really paid much attention to how the science was depicted in books. Now I look for ways that students might pick up misconceptions based on the way ideas are presented in words and/or illustrations. Picture books help me engage students in a science topic, clarify ideas, and assess knowledge and understanding.

The support from MMSA through the L-SILL project has been incredible. Throughout our three years in this grant program, my district closed a school and there have been several administrative changes. Regardless of what was going on, support continued. Site visits were valuable and provided opportunities for multiple staff members to participate in professional development. Otherwise, lack of funding would have stood in the way of off-site opportunities. Resources are now available for teachers that our district never would have been able to purchase. Inquiry science is being supported through the purchase of kits related to units aligned with curriculum. What a great resource for teachers! Science is valued more now as a content area thanks to this grant and science-literacy connections are being made. It is exciting to see the changes.

Science is valued more now as a content area thanks to this grant and science-literacy connections are being made. It is exciting to see the changes.

As a teacher, I am grateful for the opportunity to have participated in the L-SILL project. I have learned how to incorporate inquiry- based science in my classroom while utilizing a variety of strategies that help make science-literacy connections. Utilizing science notebooks and inquiry provide my students with experiences where they feel like scientists. They are excited about science. Students have had work on display for the community during science exhibits. Consistency between grade levels and a clear focus on curriculum will benefit students and impact achievement. I look forward to utilizing the resources provided to my district from this grant. As a teacher, I feel confident about my teaching and the influence I can have on students. Science is full of mysteries and questions. How exciting to be a part of bringing these experiences to others.

Connecting science and literacy through children's picture books

by Eleanor Krueger

Eleanor Krueger has been teaching at the elementary level for 30 years and taught science in grade 4 at Shapleigh School in Kittery. Eleanor used children's books throughout the science inquiry process to help children learn essential science concepts.

I have been using picture books for 20 plus years to teach and/or reinforce science concepts with my 4th graders. My collection is strong, with books covering the variety of topics assigned to the grade level. I believed I was doing a great job, until I got involved in the Linking Science, Inquiry, and Language Literacy (L-SILL) project. There was so much more to teaching with picture books than I knew.

There was so much more to teaching with picture books than I knew.

During my first year's involvement with the Maine Mathematics and Science Alliance (MMSA) L-SILL initiative, I learned about the inquiry-based 5 E process: engage, explore, explain, elaborate, and evaluate. Following these steps help structure a worthwhile inquiry-based science lesson. I admit, I was using all the steps at various times, but not on a consistent basis with solid planning. The 5Es opened my eyes – I needed to change my teaching of science. In addition to using the 5E model, I also incorporated picture books at each inquiry stage.

I used picture books to engage my students, helping to give all a common experience or background of a topic and to assess their current knowledge. One book was *Hurricane* by David Wiesner, a story about a family making preparations for the storm. As I read it, my students would share their routines to get ready for snowstorms and power outages. Students can identify with this process.

I felt like I was making progress in using children's books more efficiently and effectively. During the same weather unit, students were focusing on the question of which clouds brought what type of weather. As well as recording daily observations, students were exposed to both fiction and non-fiction books exploring this topic. Examples of books we used to support data collection during this stage of inquiry were *The Cloud Book* by Tomie dePaolo and *Cloud Dance* by Thomas Locker.

Magic School Bus Inside a Hurricane by Joanna Cole was used in the explanation stage to clarify concepts that the students were developing and make sense of their learnings.

I used *Snowflake Bentley* by Jacqueline Briggs Martin and *W is for Wind* by Pat Michaels and Melanie Rose as model books near the end of the weather unit. These are written in simple language

with parallel nonfiction information on each page. During this elaboration stage my students were able to imitate this style of writing in their own stories, further combining the language and literacy connection stressed in the L-SILL grant.

The final E, evaluation, was a new idea to me: using a child's book to have students demonstrate their acquired knowledge and understanding and pointing out misconceptions they still had. As I read *What Will the Weather Be?* by Paul Rogers, I asked for students to point out scientific errors and/or shortcomings in the text. It was rewarding to have so many kids speak up all at once, aware of incorrect or weak information in the text, and then being able to give suggestions for improvement. This assessment helped me see which concepts I needed to reinforce.

As part of the L-SILL project an online workshop was offered, *Picture Perfect Science* and *More Picture Perfect Science*. Just what I needed to further develop my skills in using children's picture books! Through the L-SILL project, four of us in our district were able to take the 6-week workshop without cost. It was so rewarding and worthwhile to collaborate with my peers both online and in person, sharing ideas on how to better use picture books. The two accompanying *Picture Perfect* resources by Karen Ansberry and Emily Morgan are full of quick, practical lessons, tied to specific books, many of which I already had. Through this course I was able to enrich my science teaching even more.

Without the L-SILL grant neither I nor my students would have been exposed to these inquiry stages. The 5 Es have helped strengthen my teaching of science and it has been rewarding to share this approach, and the picture books, with my colleagues. I thank the Maine Mathematics and Science Alliance for this professional growth.

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Discovering the science of scientists' notebooks

By Andy Weatherhead

Andy Weatherhead is a self-contained 4th grade teacher at Shapleigh School in Kittery. Andy was a fellow in the 3rd Governor's Academy for Science and Mathematics Leadership. He found that the language literacy connection between science and scientists' notebooks helped students organize their thinking and evolve their understanding of essential science concepts.

> *Science is facts; just as houses are made of stone, so is science made of facts; but a pile of stones is not a house, and a collection of facts is not necessarily science.* - Jules Henri Poincaré (1854-1912) French mathematician.

"Which box was it?" I wondered to myself. The stack of desks, chairs, and boxes in the middle of the classroom may as well have been a mountain. Its sheer enormity was overwhelming enough, but what hid inside would eclipse that with little difficulty. A teacher's first year is tough enough as it is, but add to it the teaching materials of a retiring teacher and it increases tenfold. As I poured through box after box trying to group what items went together, I found myself surrounded by piles of quasi-sorted materials that had somehow begun to merge back together. That's when I found it, a box labeled Weather. It was a rather unassuming box, well worn, and fairly sizable. What I found inside was a binder full of worksheets, diagrams, and charts. Some were so old that the blue mimeograph ink on the pages had bled through layers of adjacent pages. In the bottom of the box was a number of chapter and picture books, all relating to weather. The connections to the science concepts in the weather unit were clear. Upon an initial skim through, the books presented themselves as well chosen and highly salient for the teaching of the unit. However, the books were not enough. The worksheets, diagrams, and charts were not enough. I had my collection of facts, but could not build my house with them.

The use of scientists' notebooks was present from the very beginning of our L-SILL experience.

The use of scientists' notebooks was present from the very beginning of our L-SILL experience. The research behind their successful use in the classroom was a great hook to draw us into the L-SILL experience. However, it was the practicality of the approach that was the deal sealer. Our first exposure was at the L-SILL inaugural meeting/workshop where we were introduced to the wily adventures of some sheep and their jeep from the children's book, *Sheep in a Jeep*, by Nancy Shaw. The story was a delightful rhyming children's book that could have

been enjoyed purely for its entertainment value. The inquiry activity that followed, adapted from an NSTA Press resource, *Picture Perfect* Science, made a wonderful connection that could have been easily missed. The added opportunity introduced in the L-SILL project for students to use writing in scientists' notebooks for predicting outcomes, recording observations, and drawing evidence-based conclusions was a powerful addition to the activity.

For the following school year the phrase "sheep in a jeep" became synonymous with the use of science notebooks. The simple setup of the notebook integrated well with short, lesson-based experiments that were part of our units of study. While our use of science notebooks in the classroom was enhancing our own practice, it became much clearer that there was still something missing. Although it seems perfectly obvious in hindsight, at the time we were still searching for something to make it all click. We knew we were on to something good, but just didn't know how to make the science notebook the tool that was going to impact student learning and achievement in the way we wanted it to.

In year two of our participation in L-SILL our experience changed considerably. Having saved our first year's L-SILL funded expenditure for a science kit, we combined two years of funding and purchased a Science and Technology for Children (STC) science kit that would support our existing animal studies unit.

The STC kit provided us with an inquiry rich, cohesive unit of study with a considerable literacy component. L-SILL also provided us with an excellent professional development experience that accompanied the arrival of our science kit and included a sample student science notebook created by MMSA L-SILL staff using the teacher's guide from the kit.

We knew we were on to something good, but just didn't know how to make the science notebook the tool that was going to impact student learning and achievement in the way we wanted it to.

The unit provided a number of excellent opportunities for students to create entries in their notebooks. Over the course of the unit students were drawing diagrams, collecting and recording data, developing questions, making observations, and modifying preconceptions based on evidence collected during their inquiry investigations. It was during this second year that it became increasingly clear that consistent and cohesive use of a science notebook developed strong skill sets with students. Skills such as the claims and evidence framework helped students develop deeper understanding of science concepts. While keeping their notebooks, students displayed stronger understanding of their collected data, an increase in their level of confidence, and most importantly, greater ownership of their work.

While keeping their notebooks, students displayed stronger understanding of their collected data, an increase in their level of confidence, and most importantly, greater ownership of their work.

I collected data in regards to students' ability to make well-written, strong claims supported by the citation of specific collected evidence. Throughout the last two years of the L-SILL experience particular attention was paid to the claims and evidence framework. The data collected revealed an overall increase in the ability of students to follow the framework. The data further revealed that students showed greater growth in developing strong claims. Citing evidence in an equally strong way is still a developing skill and will help to shape goals for future years.

Students began to see scientists' notebooks as a necessary, required component of science.

In year three of L-SILL we were able to purchase a second STC kit. We were again provided with a sample student science notebook based on the teacher's guide. These two STC units were taught successively with a period of overlap. For 4-5 weeks both units were being taught at the same time. By this time, students had become extremely comfortable with the scientist's notebook. It was a welcome sight to see students taking out their notebooks before instructions were even given to do so. Students began to see scientists' notebooks as a necessary, required component of science. It is evident that students were only able to handle the simultaneous teaching of two science units because of the use of the scientists' notebook. The notebooks added a level of consistency, organization, and unity that made this possible.

Of particular note was my experience with a struggling learner this past year. The student is autistic and requires an educational technician with him at all times. Reading and writing skills were significantly below grade level and for nearly all assignments the educational technician needed to read to and scribe for that student. The appropriateness of keeping a scientist's notebook was initially questioned. As the units of study progressed, the student demonstrated solid comprehension of the science concepts. The concepts were verbalized and scribed into the notebook. The structure of the notebook allowed for a considerable level of differentiation. By this time in the L-SILL project, it had become abundantly clear that the notebook was a beneficial tool for all students, despite varying levels of detail and artistic skill. Students became acutely aware of their own strengths when it came to notebook entries. This student who struggled with writing became his own advocate for differentiating. When instructions were given to come up with lists or ideas, he would very often ask if he could draw pictures to express his ideas rather than have his words

scribed for him. His self-advocating empowered him to become more independent in the regular classroom setting.

As L-SILL came to a close, we were presented with further resources and funding, which allowed us to purchase a third inquiry-based science kit. Equipped with our experiences from the past three years and the tools of how to effectively implement scientists' notebooks, we are poised to continue the work, not only in our own grade level, but also across all grades in our building. We know that continued work on the claims and evidence framework is needed both at grade level and across grade levels. By continuing to address student needs observed through collected data, we will be able to further our work in student achievement in the science content area.

Equipped with our experiences from the past three years and the tools of how to effectively implement scientists' notebooks, we are poised to continue the work, not only in our own grade level, but also across all grades in our building.

Student's early attempt in Andy's classroom at writing a claim with supporting evidence shows vague terms and no connection to the data. Evidence does not match the data.

Question:
How does the height of the ramp affect the distance that the marble rolls?

Height of ramp	Distance Trial #1	Distance Trial #2	Distance Trial #3
1 ream	47	46	32½
2 reams	75½	80½	63
3 reams	86	88	61/2

Claim and Evidence

When the ramp is narow Youdon t a ackreit measure

the distance the marble rolls depends on how ~~high~~ ~~her~~ low

My evidence is:

that if you want it to go farther make the ruler at the middle.

Student's later attempt in Andy's classroom shows an accurate claim, and the evidence is based on the data. More work is needed for student to include quantitative data from the table as evidence.

Question:
How does the height of the ramp affect the distance that the marble rolls?

Height of ramp	Distance Trial #1	Distance Trial #2	Distance Trial #3
1 ream	24 1/2	27	24
2 reams	51 1/2	51	47 1/2
3 reams	51	49 1/2	51

Claim and Evidence

When the ramp is higher **,**

the distance the marble rolls goes farther **.**

My evidence is:

When the ruler is higher the marble goes farther.

A little reflection will show us that every belief, even the simplest and most fundamental, goes beyond experience when regarded as a guide to our actions.
- William Kingdon Clifford

The Hebron Station School serves approximately 135 students in grades K-6. It is located in beautiful Oxford County in Western Maine. The school community is housed in an award-winning school building that opened to students in September 2002.

Science drawings

by Patricia Curtis

Patricia Curtis has taught for thirty seven years in SAD 17. She has taught 1st grade in Hebron for thirty two years, with some of those years combined with kindergarten and many years serving as a teaching principal. Patricia uses her students' drawing to gain insight into their thinking. She realizes that if she uses her first grade students' drawings to gain insight into their scientific thinking, then their drawings must be accurate representations of what they are actually seeing and thinking.

Characteristically first graders are not known for their art work, especially drawing. Having taught this age group for over thirty years, I have had few children who have been willing and able to draw slowly and carefully. A child of this age wants to do something and finish it, feeling pride in merely completing the task. It had always been a struggle to routinely request a child to work slowly and add details. But now, having participated in several L-SILL workshops, the concept of detailed drawing is part of my everyday classroom expectation.

Nancy Chesley, elementary science specialist from MMSA, made us believe children, even six year olds, can draw and draw well. Through her L-SILL workshops, I have seen work from Nancy's students and watch Nancy model clear, concise, expectations for us to use with children. Implementing those strategies has transformed my expectations when children draw.

I begin each school year by slowly reading and discussing each important aspect in the book, *What Is A Scientist?* by Barbara Lehn. This lesson sets the tone for whenever we do science in first grade, as I will continually refer to the concepts presented in that book. Just hearing the word science gets the children all excited, as they feel very grown up doing science! No matter what the activity being done, I need only the simple reminder of how a scientist works to get the children focused or redirected.

…the concept of detailed drawing is part of my everyday classroom expectation.

The children learn that to do science they must act like scientists. They cannot rush because scientists don't rush. They cannot leave out labels or details because the work would not be complete. Using science notebooks to record our learnings and thoughts has made me realize the importance for children to draw like a scientist.

Using science notebooks…has made me realize the importance for children to draw like a scientist.

In workshops Nancy showed us how to model drawing for children in order for them to not only learn, but to represent their observations accurately. Watching Nancy helped me learn how to model the drawings of what I want

my first grade children to do. Starting in September with our science work on apples, the children begin their first scientific drawing. The children not only watch me complete my drawing, but they also have a magnifying glass to aid them when they add the details of their apple. The children learn to label in the first few weeks of school now! These first simple scientific drawings help me see who has challenges with left to right orientation and following directions. This past year I had a boy write everything backwards when he labeled the parts of an apple. This alerted me to possible visual difficulties with him early on, which were confirmed as we got into reading.

The quality of the science notebook on chicks is remarkable. The detailed notes and labeled drawings entered each day are invaluable when they use them to make their own chick life cycle book.

Throughout the year we did comparisons such as apples to pumpkins and created many science notebooks. The aspect of drawing was a huge journey of growth for the children. All their work was kept in a portfolio. The children were able to witness their own growth in drawing as well as in the content of their writing. Discussing the addition of details to their science drawings, students were able to make the connection to the necessity of adding details to their stories/sentences/writings in language arts. The details and labeling enrich their vocabulary and cause their observations to become more concise and their thinking and questioning grow. The children become more comfortable taking risks in their drawings and their questioning.

Our last big science unit of the year is the life cycle of a chick. By the end of the year the children have become such amazing scientists! The quality of the science notebook on chicks is remarkable. The detailed notes and labeled drawings entered each day are invaluable when they use them to make their own chick life cycle book. Each child is always so pleased with his/her book because to them it looks so much like the drawings they have seen in the books we use during our study. One girl, a couple of years ago, was so pleased she entered her chick book at the Fryeburg Fair. It won a special judge's award! At the end of this essay is the chick work done by a boy whom I taught this past year. It shows some very detailed drawings by a six year old student in first grade.

I have had parents, fellow teachers, and administrators all comment on how advanced each child's work has become. The children become comfortable using terms like embryos without pause. In fact, our second grade teacher, Sarah Otterson, told me that when she shows her students the bean embryo all the children are excited to tell her about the chick

embryo. They see the connection in the vocabulary and the drawing because they had learned how to be a scientist in first grade!

L-SILL has helped me grow as a teacher. I have always had high expectations for my first grade children, but only in reading and writing. Now I have higher expectations in science because I have seen what six year old children can do!

Science is done more often in my classroom now. The children absolutely love it when I say it is time for science or what our new unit of study will be. The quality science literature we now have to help us engage the children in reading science is wonderful. When I ask them to select a book to read for assessment, more often they will choose to read a science nonfiction piece over fiction! What a transformation for all of us these past few years!

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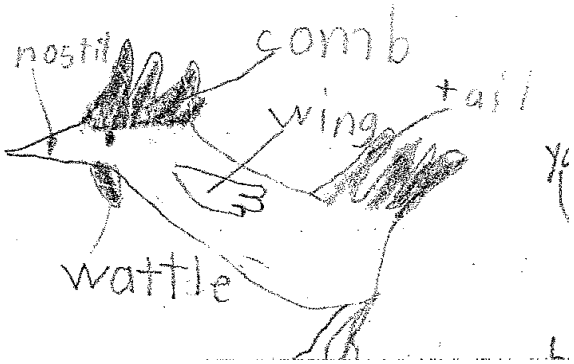
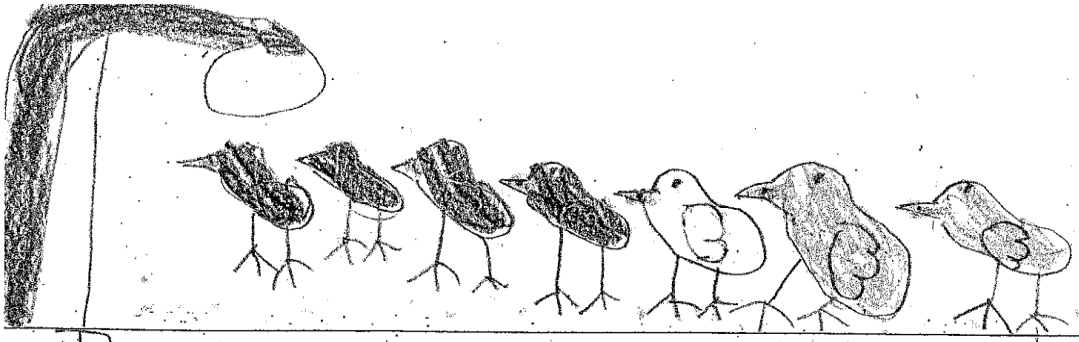
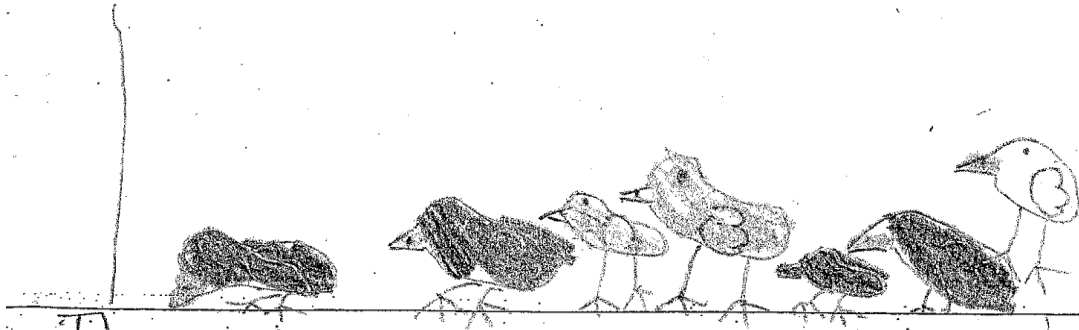




There are seven chicks in a box. There is a light and food.



They step on each other. They sleep a lot. They eat the food in the box.

Science, inquiry, and language literacy: Essential components for understanding the natural world

by Lydia Eusden

Lydia Eusden has been teaching grade 5 at Hebron Station School for the past five years. Her degree in botany and plant pathology has always supported her nicely in making connections to science with her students. She uses the language literacy components of reading, writing, and speaking to support science inquiry as students study the natural world.

"Today, students are aware of the global threats to the environment - but their physical contact, their intimacy with nature, is fading." These words, written by Richard Louv in his book L*ast Child in the Woods*, is precisely the reason why I teach inquiry-based science and connect it to literacy components for my students. Each year, my fifth grade students seem to know less about the natural world in their own backyards. For this reason, I bring nature into my classroom as often as possible.

A unit that I teach to my grade 5 students, who range in age from 9 to 11 years old, is on the topic of food chains. This fairly broad topic can and does link to students' everyday lives if you show them the paths of connection. Opening the unit is a brainstorming session - what does the term food chain means to them? After a quiet 5 minutes of thinking they write down key words or phrases in their individual student scientist's notebook. Essentially, any idea is an acceptable answer because the motive is to try to get students to think through what they have previously learned and what they think they know and to get these ideas written in any form where spelling and grammar are not the primary focus. The purpose of this opening activity is to enable each student to have something to offer to the rest of the class and to grab his/her curiosity.

… I teach inquiry-based science and connect it to literacy components for my students.

As the class shares individual ideas, I have students continue to write down in their own notebooks others' comments that are meaningful to them. The floodgates of hands raised builds as one idea gives a second student a new connection. Each student is empowered because s/he has some nugget to offer. The non-writers can speak their ideas out loud while the writers can be busy writing down concepts from the brainstorm which I am building on the whiteboard in front of them. In their excitement, students are writing without

In their excitement, students are writing without much effort because they are so excited to share their thoughts.

much effort because they are so excited to share their thoughts.

The food chain unit is broken into three separate scientist notebooks; producer, primary consumer, and secondary consumer. Each student has hands-on experiences with each of the three units which they keep track of in their own scientist's notebook. There is ample space for students to write their scientific questions, predictions, observations, data collection, scientific drawings, conclusions and reflections. No two notebooks are ever the same as no two students are ever the same. Each student looks at what they have studied and observed with a slightly different interpretation. I believe science education is perceived differently by students in my classroom because the science is there in front of them and not written in a text or captioned in a glossy photograph for the student. The science has been made alive.

Each student is responsible for his/her own experiments. Responsibility is an important character trait to develop in a 10-year old child. If they become engaged in their cup of producer oat seeds being watered, measured, scientifically drawn and evaluated, there is a stronger chance they will put forth conscientious effort in their scientific learning. I do the experiment along with the students so they see that I am learning along with my young scientists. Modeling questioning, writing, and drawing slowly exactly what I see shows students how to act like a scientist. Also, it shows that an initial idea may not be correct and that is acceptable. I honestly think that my students were relieved to feel that the pressure of getting it "right" was taken away.

Students liked to see themselves as real scientists. It made them feel important.

The second part of the unit for primary consumer had each of the students be caretakers of two crickets in a terrarium which was positioned on their desk. Throughout the day they were to observe their crickets' behaviors, take notes, draw exactly what they saw, feed and water them and be responsible for their staying alive. This active role not only made the students responsible but also intimate with the investigation. They needed to observe when, how, and if the crickets ate the oat plants. Students were so engaged in their terrariums that at times other daily tasks were interrupted with student observations. For example, in the middle of solving a math word problem one day, a student burst out loud with, "Mrs. E. my crickets are mating!" This observation made a nice connection to our unit on puberty and reproduction. This was meaningful learning!

Students liked to see themselves as real scientists. It made them feel important. For students who came from homes with no pets, it gave them the thrill of being a pet owner. The opportunity to observe animal behavior patterns was especially meaningful. One particular student whose family has few means of support was excited to come to school

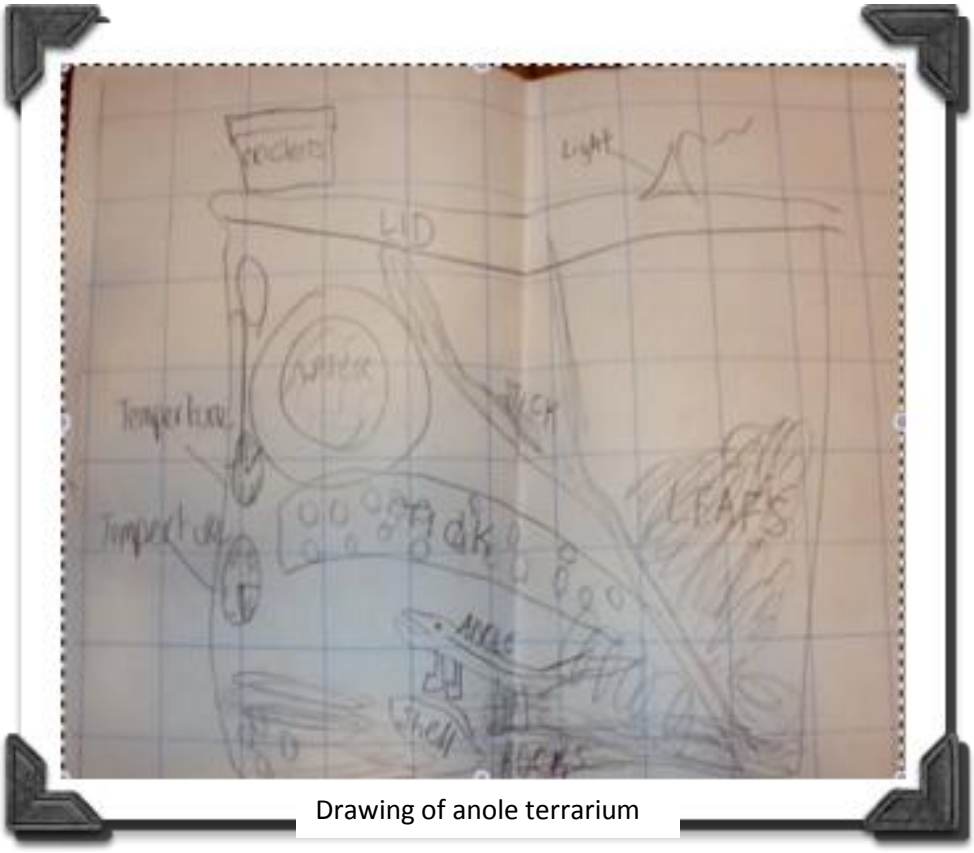
every day to see how his "babies" were doing. Coming to school was an act he looked forward to because he had his crickets to care for and a scientific investigation to document.

In addition, effective use of nonfiction books supports experiences difficult to bring to the classroom. Students made the connection from my read-aloud book, *Everybody is Somebody's Lunch* by Cherie Mason, to the unit. The parallels were many for students. They were able to recognize different flora and fauna because of the superior scientific watercolor paintings. This impacted them immediately because they recognized the need to be accurate in their own drawings. Furthermore, they were able to notice other food chains in the story, which were different from what they already knew.

In my end of year Grade 5 Reflections, most of my students wrote that science was their favorite subject because of the inquiry-based investigations. At student-parent-teacher conferences, students were proud to share their individual scientist's notebook with their family members. Often parents would say, "I heard all about it at home!" This is a thrilling part of being a teacher because I knew I had motivated my students to be conversant about what they were learning at school with their family. Ownership of learning with family support is a key component to student achievement.

My participation in the L-SILL project provided me with important insight to the structure in presenting science to

A cricket home



Drawing of anole terrarium

my students. The book, *Using Science Notebooks in Elementary Classrooms* by Michael Klentschy, was extremely helpful because it explained the ideas associated with children's cognitive capacities, the need for hands- on activities in the classroom, and a framework for helping students organize their thoughts on paper. Many of the experiences presented at the L-SILL workshops were new refreshing ways to look at a scientific concept for me. They were simple but meaningful. The workshops also brought forth engaging and invigorating teacher discussions including the connection of reading and writing science to the writer's workshop model. These discussions strengthened the notion that reading and writing occurs in science as well as other subjects. L-SILL improved my scientific teaching approach to more engaging and significant steps.

"Sometimes, the catalyst is a principal with vision." (Louv, Richard pg. 212). I agree with Louv's statement because it is the actual seeing, touching, smelling, and hearing with the senses which fires student interest in learning. If a student is excited, observing and writing like a genuine scientist, their learning is meaningful. Especially for the 10-year old reluctant readers or writers, this may be the one nugget which allows them to feel interested in education or empowered to write about what they learned. With the momentum in a student's energy for wanting to know more about the natural world, hopefully s/he will take that curiosity and continue to build reasoning skills. More importantly, students should become better stewards of the delicate ecosystems of their own backyards and points beyond.

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Language literacy as a support for science instruction

by Sharon Johnson

Sharon began her 10th year at Hebron Station School, and she is currently teaching grade 6. Sharon uses several L-SILL recommended resources and incorporates language literacy as a critical element of her science instruction.

The spark, the interest in science Mrs. Otterson placed in me then, has since grown into a roaring fire. This statement was shared with the families and the school community at the Hebron Station School's sixth grade celebration. The student was reflecting on his second grade science experience. Hebron Station School had been in its second year working with the L-SILL program when this student was in second grade. The student continues, *When I look back now to the beginning of the (6th grade) year, I see all of the different things we did in science. The very first science experiment involved a mitten and a thermometer. Mrs. Johnson read the book The Mitten by Jan Brett. Each group got a fleece mitten and a thermometer.*

L-SILL helped me, as a teacher, orchestrate science instruction rich in inquiry supported with language literacy. *The Mitten* by Jan Brett is used as a formative assessment probe to elicit students' ideas about sources of heat energy. Students record the temperature of the thermometer outside the mitten in their scientists' notebooks and then make a prediction as to how the temperature of the thermometer might change once placed in the mitten. Many students predict that the mitten will make the temperature rise. This activity helps students to differentiate between a heat source and objects or substances affected by a heat source. Throughout this curriculum, clearly developed upon principles emphasized in the L-SILL project, students ask questions, make predictions, and conduct investigations. They use science notebooks for recording data and reflections.

Oil spills have done untold damage to the world's oceans. L-SILL provided a teacher resource, *Picture Perfect Science*, which led to exploring an oil spill using the picture books *Prince William* (fiction) by Gloria Rand and *Oil Spill!* (nonfiction) by Paul Berger. In *Prince William*, Denny rescues a baby seal hurt by an oil spill in Prince William Sound in Alaska. She watches as the seal recovers in a hospital tended by dedicated rescue workers. In *Oil Spill!* students learn facts about how oil spills occur and how they are cleaned up. After reading *Prince William*, students create their own oil spill investigations and explore methods for cleaning up the spill. Science notebooks play a vital part in the lesson. Students working as scientists must record their procedures, observations, and conclusions.

Oil Spill Disaster in the Gulf written by Mona Chiang, Cody Crane, Karina

Hamalainen, and Lynda Jones provided students with a look at the 2010 oil spill in the Gulf of Mexico. Cleanup expert Nancy Kinner, Director of the Coastal Response Research Center at the University of New Hampshire, visited our school to talk to students about her work in the Gulf oil spill. Through discussion, demonstration, and a hands-on experiment, students investigated how different materials were used to clean up the oil spill in the Gulf. Students tried using booms, skimmers, and dispersants. Ms. Kinner explained to students how dispersants were used to clean up the oil spill. The chemical dispersants help break up the oil into tiny droplets that get distributed into the water instead of floating on the surface.

Animals and Surviving Change and *Animals Adaptations,* books by Kate Boehm Jerome, provided the background information for our study of classification. Students read the books and completed a "mock" DRA (Developmental Reading Assessment) in preparation for the spring district DRA. The books introduced students to many new vocabulary terms. From reading the books, students developed a number of different inquiry investigations based on adaptations, classification, and camouflage.

L-SILL provided a network of folks working to promote science. Working with the Maine Mathematics and Science Alliance and the Gulf of Maine Research Institute, I was introduced to the Vital Signs invasive species program. Students explored the Hebron Station School Nature Trail looking for Mile-A-Minute Weed. Through observation, photography, and analysis students verified that Mile-A-Minute Weed does not exist on the nature trail. Students posted their finding to the Vital Signs website. Their field notes were recorded as they conducted their investigation, then revised and edited for publication on the website. Students received feedback from real scientists which was pretty exciting.

Literature, science notebooks, and guided inquiry continue to guide science instruction in my sixth grade classroom. As one student put it, "I can honestly say that classroom science has been awesome!"

In summary, L-SILL workshops provided opportunities to explore inquiry science while making a literacy connection. Literature, science notebooks, and guided inquiry continue to guide science instruction in my sixth grade classroom. As one student put it, "I can honestly say that classroom science has been awesome!"

Science inquiry + Language literacy = Minds-on

By Sarah Otterson

Sarah Otterson has taught second grade for 21 years in the town of Hebron, Maine. Sarah and other teachers in her district have worked to make Hebron Station School an active, authentic learning place through classroom science lessons and through getting students outdoors with the development of gardens, school yard habitats, and nature trails.

Science has always been a key for learning, and at the same time, a conundrum. Children love science, but what is the best approach to maximize science learning? Children very happily take part in science activities, but how does one teach them to ask questions, think critically, and piece together something they don't even know yet? Many elementary teachers have a limited knowledge of science, and they are overwhelmed by the concepts and the preparation necessary to conduct science investigations in the classroom. Professional development in science for practicing teachers seems necessary, but hard to find.

Children love science, but what is the best approach to maximize science learning?

That began to change for the teachers at Hebron Station School (HSS) with L-SILL. In October, 2005, I took two second graders and two third graders from HSS to South Portland. We visited National Semiconductor, a facility that manufactures computer chips and that requires highly skilled employees. There we attended the kick-off for the Linking Science, Inquiry, and Language Literacy (L-SILL) project, which was to be funded by National Semiconductor.

Those four children are in middle school now, but that day, they, along with children from about twenty elementary schools, felt very grown up as they ate a fancy lunch and participated in a science investigation. They listened to our governor's wife, Karen Baldacci, talk about the need for them to work hard in science and just maybe grow up to be a scientist or an engineer. They listened to an oceanographer and children's author, Mary Cerullo, who wrote *Sea Soup*, talk about her fascinating work. The students went home inspired with stars in their eyes.

That carefully planned, perfectly balanced first meeting set the tone for all other L-SILL professional development. Lynn Farrin and Nancy Chesley, project leaders for the L-SILL initiative, have given L-SILL teachers a foundation of knowledge and the tools to support other teachers in their quest to learn how to go about science teaching. They have been fabulous models of good classroom practices.

At first, I think Lynn and Nancy must have been discouraged by the slow pace of change that was happening as a result of their science inquiry and notebooks teaching. How could administrators, teachers, and their students not be utilizing and benefitting from science-literacy connections? Then, at the 2008 summer L-SILL Summer Inquiry Academy in Camden, Maine, Lynn and Nancy gave all participants a challenge: go back to your schools and do an inquiry/science notebook workshop for your administrators and teachers. As HSS's team, Lydia Eusden, who teaches 5th grade, and I would make what we had been learning explicit to our colleagues. Teams of teachers planned their workshops for the fall over several sessions during the Academy, then they shared that planning with the group. This sharing time was immensely helpful to Lydia and me. Our plans were amended and made better as a result of listening to other teams' sharing.

Another key stimulus from the Academy was learning about the Lawrence Hall of Science curriculum, *Seeds of Science/Roots of Reading* program. From that point, I seemed to finally get what it would take to move the ball forward. Or maybe it was more that L-SILL was beginning to make sense to other movers and shakers in the district.

I am a member of Oxford Hills School District Science Curriculum Committee.

L-SILL kick-off luncheon at South Portland National Semiconductor.

It was lucky that the committee's summer work days were scheduled a few weeks after the L-SILL Academy. As a direct result of L-SILL, it was decided that copies of Michael Klentschy's book, *Using Science Notebooks in Elementary Classrooms*, would be purchased for all K-6 teachers. At our professional development workshop days over the course of the 2008-2009 school year, teachers would have the opportunity to read the book in sections, discuss notebook strategies at grade level meetings, and try out new learnings and ideas in the classroom.

Seeds of Science/Roots of Reading curriculum materials were introduced at the science curriculum meeting as well. This laid the groundwork for the purchase of Seeds/Roots leveled texts for students the next year. Teachers loved the *Seeds/Roots* materials.

At Hebron Station School, the fall Inquiry/Science Notebooks workshop resulted in all teachers agreeing to choose and try out one science investigation from the books Picture *Perfect Science Lessons* and *More Picture Perfect Science Lessons* by Karen Ansberry and Emily Morgan. (It should be noted that a copy of *Picture Perfect Science Lessons* was given to school teams at the first meeting of administrator/teacher LSILL teams in December, 2005.) This was a modest start, but with a new principal, a recently graduated new teacher, and several teachers out of the practice of teaching science, I felt exhilarated! I worked hard to make sure that every lesson chosen had the picture books and all the necessary materials. My hope was that this common experience would jump start a cycle of conversations about science teaching and strategies for integrating and applying what was learned to other science lessons. I also knew that teachers had the Klentschy book, which would be a resource as well.

My hope was that this common experience would jump start a cycle of conversations about science teaching and strategies for integrating and applying what was learned to other science lessons.

One last key to ensure that the synergy of science and language literacy was recognized and embraced by an even greater number of elementary teachers and principals was the response of our district's literacy coaches. These coaches have taken the lead in trying to improve students' reading skills and high stakes testing scores. What they consider important to teach guides what and how classroom teachers teach.

Nancy Chesley provided three inquiry and science notebooks workshops for Oxford Hills elementary teachers in the fall of 2010. Among the teachers that participated in the workshops were two literacy coaches, Lynn Brown and Mary Reed. Here is what Mary had to say about the workshops and about writing in science in particular, "I was curious about what the recommendations for science writing would be, and I was

pleasantly surprised with the answers. I really liked that, while students are not required to do a great deal of busy work, it encouraged frequent response."

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I continue to model science education and put it at a higher priority than it seems to be right now. I hope that increasing the frequency and authenticity of writing through science will help others to see that it isn't just science that we're working on here. I am hoping to help the new incoming teachers next year, as well as the literacy coaches, understand and appreciate the power of the science-literacy connection and that this will help to spread the good news.

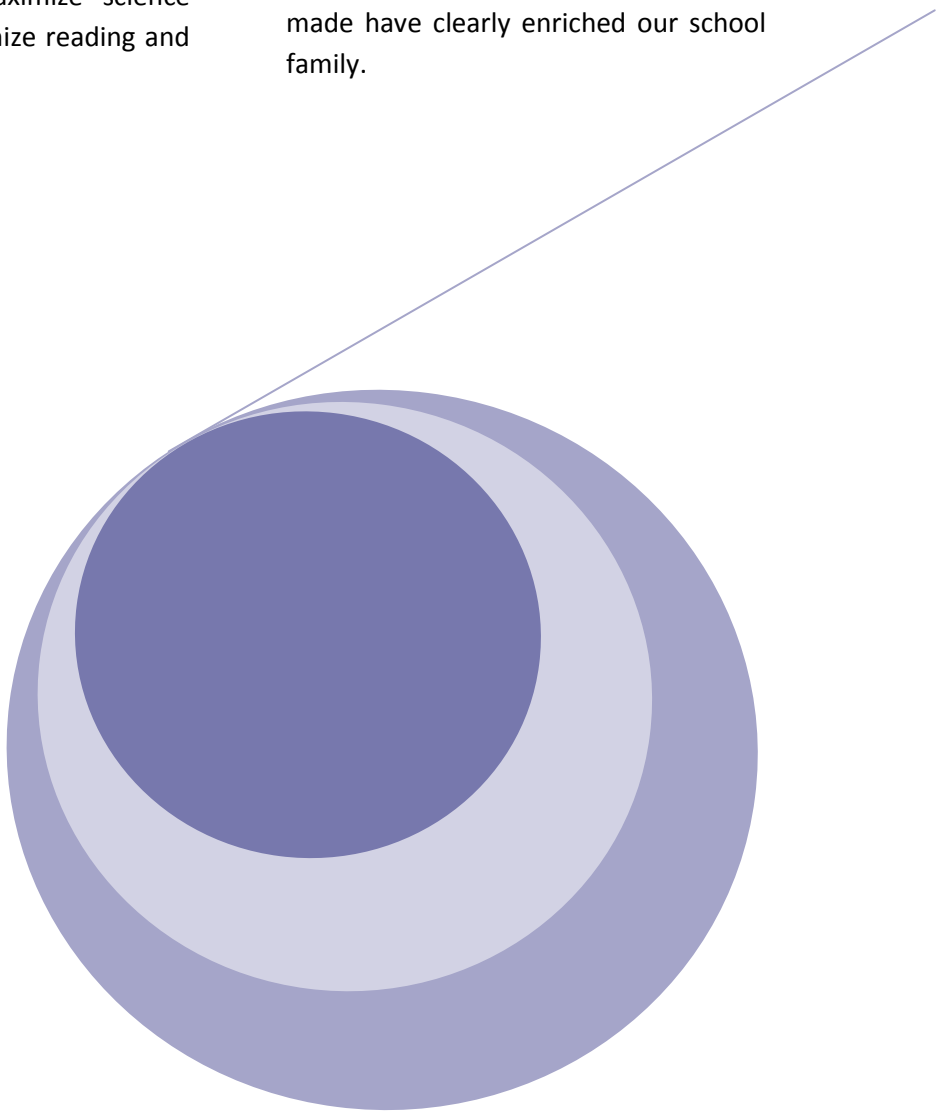
Fast forwarding to the 2011-2012 school year ... It seems as if in our own corner of the district, Hebron Station School teachers and their students are learning to think through and participate in carefully crafted science investigations that fully incorporate reading and writing. Teachers are seeking out new opportunities with confidence. Sharon Johnson, our 6th grade teacher, and her students have become immersed in science with the new Energy Heats Maine and the Vital Signs units. Maria Panakis, our 3rd grade teacher, is using guided inquiry for her rocks and force and motion units. Trish Curtis, our 1st grade teacher, has science going all year round with her germs, moon and sun, and animal life science units. Through L-SILL funding, she received a Education Development Center (EDC) Balls and Ramps science kit this year. That kit will strengthen our physical science strand. Trish's 1st graders' science notebooks are a wonder. Lydia Eusden's fifth grade students are on fire about science!

My second grade students did exemplary work in their science notebooks last year. They are very proud of their work. At the beginning of the school year, L-SILL funded a Science and Technology for Children (STC) Plant Growth and Development science kit for the second grade with which the students and I followed Seattle Public Schools' model of writing in science. My students have also used Seeds of Science/Roots of Reading leveled texts as models for writing reports, planning an investigation, and for documenting change over time in a nature notebook.

Looking back to my original question: "What is the best approach to maximize

science learning?" I think the answer is to engage students with terrific, age appropriate science concepts and materials and then explicitly teach students to use science notebooks for many purposes: to record questions, predictions, plans for investigations, to collect and record evidence by observing, drawing, making charts and graphs, to make claims backed by evidence, and then to answer their original questions in their conclusion. This approach will maximize science learning but also maximize reading and writing learning. Every single one of the science notebook strategies builds the corresponding skills in reading and writing and builds critical thinkers!

I feel so grateful that Hebron Station School students and teachers could be part of the L-SILL project. The professional development and resources that we have been given are truly inspiring. The professional community that we have become part of and the friendships that we have made have clearly enriched our school family.



Maine L-SILL Schools

Belgrade Central School, Belgrade
Dike-Newell School, Bath
Durham Community School, Durham
Elm Street School, Mechanic Falls
Fisher-Mitchell School, Bath
Hall-Dale Elementary School, Hallowell
Hebron Station School, Hebron
Helen Thompson School, Gardiner
Jameson Elementary School, Old Orchard Beach
Jefferson Village School, Jefferson
Kennebunk Elementary School; Kennebunk
Laura E. Richards School, Gardiner
Livermore Falls Middle School, Livermore Falls
Madison Elementary School, Madison
Minot Consolidated School, Minot
Morse Memorial School, Brooks
Nickerson Elementary School, Greenville
Pembroke Elementary School, Pembroke
Pittston Consolidated School, Pittston
Prescott Memorial School, Washington
Readfield Elementary School, Readfield
River View Community School, Gardiner
Sea Road School, Kennebunk
Shapleigh School, Kittery
South Bristol Elementary School, South Bristol
Southport Central School, Southport
St. George Elementary School, Tenants Harbor
Surry Elementary School, Surry
Sylvio J. Gilbert School, Augusta
Teresa C. Hamlin School, Randolph
Whitefield Elementary School, Whitefield
Woodland Elementary School, Baileyville
Woolwich Central School, Woolwich

Maine MATHEMATICS and SCIENCE Alliance

Linking Science, Inquiry and Language Literacy
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