November 2006

The Gilbert Elementary Science Program

Science for Writing
and
Writing for Science

This evaluation brief is supported by the National Science Foundation as part of its Local Systemic Change Initiative. The brief highlights the current status of science teaching in the Gilbert, Arizona School District. The brief highlights four key findings from an exploratory study conducted by Inverness Research of teachers' use of science notebooks in Gilbert, Arizona's elementary school classrooms. The findings highlight the importance of continued district support for the key program elements necessary to maintain the quality of science teaching and learning which resulted from the NSF investment in Gilbert Public Schools.

For more information see www.inverness-research.org.

Executive Summary

Gilbert Public Schools elementary science program integrated writing into their hands-on kit-based science program by supporting teachers to learn to use science notebooks with each science unit they teach. These notebooks provide the opportunity for students to practice expository prose within the context of science learning.

In 2004, Inverness Research Associates conducted a small scale, preliminary study of teachers' use of non-fiction writing to support science learning. The study found that writing in science enhances the quality of Gilbert's science curriculum and its language arts curriculum. This type of writing both enhances science content learning and fills in a gap in the traditional elementary language arts curriculum by offering students practice in non-fiction writing. It also provides more opportunities for diverse learners to show their learning than exist in a typical science curriculum.

The study also found that professional development support is essential for teachers to learn how to use writing effectively to support science learning and especially to know how to use science as a context for practicing expository prose. The initial kit trainings, which the district requires teachers to take before teaching a kit, introduce teachers to the use of writing in science teaching and learning. However, Gilbert's Science Resource Teachers designed and implemented a series of three Science Notebook Workshops, which integrate with and support kit-based teaching. The study found that the teachers who were most skilled in using science notebooks had taken at least two of the three Science Notebook Workshops.

With the end of National Science Foundation (NSF) funding, the district is charged with sustaining the program it built with the federal investment. As discussed in a separate, companion document,[1] this district is already sustaining two of the three essential components of the elementary science program – the program leadership and the curriculum and materials support. The third component, professional development, is also needed for teachers to continue to learn to create high quality learning experiences for Gilbert's students. The remaining challenge the district faces is to find the funding to provide teachers with this support.

[1] *The Gilbert Elementary Science Program: The Infrastructure Needed to Sustain High-Quality Instruction,* Inverness Research Associates, November 2006

Background

Several years ago, evidence began to emerge (in Gilbert and a few other National Science Foundation-funded districts[2]) nationally, that suggested elementary, hands-on science investigations offer potent substance for writing practice and that writing enhances the learning of science concepts.

The Gilbert elementary science program first implemented its three levels of science notebook professional development workshops in 2001-2002. The following year, teachers began to use science notebooks increasingly in conjunction with the district-adopted science units. The program leadership was excited by what they saw and wanted to document the value and potential of writing in science for enhancing literacy as well as science learning. Additionally, the end of National Science Foundation (NSF) funding was quickly approaching, and the project leadership was looking for data to help them identify the elements of their science professional development program that were most essential to sustaining the high-quality program they had developed.

In 2004, the director of the Gilbert elementary science program asked Inverness Research Associates, the independent evaluator of their NSF-funded Local Systemic Change (LSC) Initiative in science, to conduct a preliminary study of how teachers and students were using writing in science and the extent to which the project's science notebook workshops influenced teachers' teaching.[3] The findings of this study are important to share because, with the termination of NSF funding, the Science Notebook Workshops are threatened. The district does not have internal funds to continue to release teachers to attend the workshops.

The four major findings of the Inverness study have important implications for the professional development program the district offers teachers in science and for maintaining the quality of the science and language arts learning for students. These four key findings are discussed in more detail below in the following section.

- When used most skillfully, science notebooks enhance student learning in both science and language arts. Writing improves students' learning of science concepts and skills, and science offers a rich and immediate context for developing writing.
- Especially noteworthy was that writing in science adds a new dimension to the broader elementary language arts curriculum: the opportunity for elementary students to learn non-fiction, expository writing.

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[2] Inverness Research Associates has studied the Seattle Elementary Expository Writing and Science Notebooks Program. The reports of these studies can be found at http://www.inverness-research.org/reports_proj.html#Projects_S-U

[3] Inverness Research Associates conducted an exploratory study for the Gilbert Elementary Science Program which looked at how teachers use science notebooks. A group of six researchers read, thought about, and discussed 40 notebooks (out of a sample of 60) from five different grade levels. We also observed classes of teachers using science notebooks and interviewed students and teachers about how they think about and use them. The criteria that we used in looking at the notebooks and classrooms reflected the Gilbert elementary science program goals, the National Science Education Standards, and Gilbert Public Schools Curriculum overview of ongoing developmental objectives in reading and language K-6.

- Science notebooks allow students with diverse learning styles to have access to learning science content while at the same time supporting their literacy development.
- Importantly, the study found that the district's series of three Science Notebook Workshops was the single most important resource for teachers to begin using writing and notebooks in their science teaching.

Notebooks support science learning at a deeper level and with more rigor, provide the opportunity for students to link inquiry to science conceptual learning, and are a place for students to articulate their learning and draw conclusions from their hands-on experiences.

In the best notebooks, we saw documentation, observations, and recording of data. The students then wrote their conclusions, connecting their investigations to a significant science concept. The notebook served as a bridge between the activity and the science concept. A second grade student's work in Soils exemplifies this. This student did the hands-on activity, learning how different soils interact with water.[4] She then wrote about it, using careful descriptive language related to her observations using her senses.

> *Sand will not ball but it can make stuff. And it can stick if its wet. When it was wet it felt different and felt like bumby rocks. When Humus gets wet it got gushy and it can make a ball. It felt very gritty but good to. It smelled like grass, and flower, and leaves it smelled very good like a garden. It felt soft and squ[i]shy and mushy and was very very black. When clay gets wet it sticks so much that you could just mush the clay together and roll it around and then you made a clay ball.*

In a later lesson in the same unit, another second grade student applied tests he had learned to help identify a mystery sample. He reported his conclusions with supporting evidence in his notebook:

> *The wet m[o]isture feels like cold gooey and hard. And Spongey. Whe[n] I roll it, it rolls in to a ball. I think it has Orange stuff and black spots in it. My smear tells me it has clay and Humus in it, because it has black orange, and brown stuff.*

The entry shows what the student was learning – that soils have different characteristics and can be identified by performing simple tests. These two entries begin to create a picture of how recording and writing in a science notebook is a cumulative record for students, which is quite different from individual worksheets and handouts. Without writing about their learning, these lessons would have more likely resembled fun activities (mixing water and dirt) than science. A third grade teacher explained that before notebooks, she used the single page handouts from the kit. She said that the quality of thinking, learning, and writing with science notebooks was far superior:

> *We used to do single-page entries, worksheets from the kits. Some are insulting to the intelligence of kids; they make kids think less than they can.*

[4] Soils Lesson 4 – When Soil Gets Wet.

The evidence showed that science notebooks provided a place for students to make the link from the hands-on activity to the science concept, making their investigations authentic and purposeful.

The notebooks added a new dimension to the elementary language arts curriculum while also addressing district language arts objectives.

The kind of writing we saw in the notebooks differs from writing opportunities in a normal language arts curriculum because writing about science is a way of making sense of the natural world and experiences outside ourselves. This contrasts with the writing opportunities offered in the language arts curriculum where the students' reference points are themselves in relation to characters and plots in stories and literature. Both kinds of writing are important to learn, but the addition of non-fiction writing in the science curriculum begins to create a much broader and fuller learning opportunity for students that is critical to them, especially in their futures as middle and high school students. A sixth-grade teacher said that writing supports long-term memory and it pushes students to clearly state their learning:

> *Writing [in science] cements what they do. It helps long-term memory with new concepts…Students have to take a stance and justify [their claims].*

A third grade student's writing about his plant's growth spurt[5] is a good example of expository writing. This student used data to support his claims, a strategy all researchers use when writing.

> *My plants growth has changed a lot since the first day I measured it it was one cent. three quarters tall, now it's five in a half cent. My plant has five buds between the true leave, and has six leaves.*

The next entry was the following:

> *"My plant has changed a lot since yesterday it was 5 ½ cent., and today it's 7 cent. tall! My plant used to have 4 buds and now it has five! I predict tomorrow it will be a half a cent. taller." (accompanied by a drawing of the plant with buds, true leaves and seed leaves labeled accurately)*

The study found that hands-on investigations provide rich and immediate content about which students can write. Notebooks give students the opportunity to write while they are involved in a learning activity, which may be unique to science in many classrooms. This kind of literacy experience, where students write about something very immediate, is important for all students, but especially English language learners, special-needs students, early literacy learners, and students who may have had limited exposure to a wide variety of experiences in their lives. A first-grade teacher attests to this for her early literacy learners:

> *Science notebooks are an integral part of my science and language arts curriculum .... It's hard to get first graders writing but science gives them something to write about.*

[5] Plant Growth and Development – Lesson 7: Observing the Growth Spurt

Our broader research of the Gilbert elementary science program, described in a separate brief titled *The Gilbert Elementary Science Program: Providing Students with High Quality Learning*, suggests that, unlike students in 85 percent of the districts nationwide, most of Gilbert students are consistently experiencing high quality science lessons. This translates into many rich and immediate opportunities about which students can write.

The notebooks also offer significant opportunity for practicing the district's language arts objectives. Most of these objectives are related to what the district calls composition skills and written communication formats. Notebooks, as a cumulative record of inquiry and learning of science concepts, are also a resource for report writing, another district language arts objective. We found teachers beginning to use science notebooks this way. A fifth-grade teacher had her students write a report on floating and sinking from science rather than a book report:

> *I have activities where they have to use their notebooks for other activities…[That way] we can do expository writing for science in language arts time.*

Science notebooks give students the opportunity to communicate their science learning in a variety of ways. They allow access to the learning while supporting literacy development.

A major finding of the study was that science notebooks are good for diverse learners and ensure that science is for all students (a principle of the National Science Education Standards). When implemented with care, science notebooks provide students of differing abilities and competencies with opportunities to write about science and to express themselves in their own unique ways. These writing opportunities help students of different abilities learn. The notebooks actually allow every student an entry point for their science learning. They offer a place for all students to show what they are wrestling with. In doing this, they accommodate diverse learners. A second-grade student was a slow writer, but the teacher gave him extra time to complete the task. His learning was evident in the following entry he made after conducting a test on different soils.

> *Sand will not ball, but I can make a sand castle out of it when its wet. When its wet it feels sticky when humus gets wet it smells like a garden. I can make it a ball.*

Several years after we conducted this study of writing in science, we talked to middle school students to see what they remembered from their elementary science classes. We specifically asked them if they had used science notebooks in their classes and the purpose for which they were used. We found that different aspects of science notebooks were salient for different students. One student remembered his science notebooks as an organizational aid and a cumulative record of what he did in science.

> *For me, I am kind of unorganized and so the notebook is altogether and I can't really lose it and that helped. And each day we had to open it up and you see it.*

Others said they recorded data, drew, wrote, answered, and asked questions in them.

> *If we do a lab, we have to write down day by day data to see how it is improved.*

> *You get questions from…the board…[to write about] and you [also] have to ask the questions [in your notebook].*

Students did, in fact, remember their science notebooks as part of their elementary science experience, and some even remembered using them in several different grades as this middle school student's comment indicates:

> *I had one in fifth grade and I had one in fourth and sixth grade. Fourth grade for the rocks and sixth grade I remember.*

Professional development for writing in science is essential for teachers to learn how to use science notebooks to support science learning and to use science to teach writing.

In 2001-02, the leadership of the Gilbert Systemic Science Project began to design and implement a series of three high-quality Science Notebook Workshops as part of their broader professional development offerings for classroom teachers. They intentionally integrated writing with the district science units. Before this, teachers neither used science notebooks nor intentionally incorporated writing into science learning.

These workshops also served a secondary purpose in that they gave teachers the justification they needed to spend time on science. With pressures from No Child Left Behind, literacy and mathematics were top curricular priorities in Gilbert, leaving little time for science education. A second-grade teacher explained how including writing in science had given her the time she needed to spend on investigations:

> *I use a lot of my writing time for the science notebooks so that I can use all my science time for doing the hands-on activities.*

Thirty-nine of the 45 teachers we interviewed over the past two years told us the Science Notebook Workshops, or other professional development focused on the use of writing in science teaching, were the most helpful resources in learning to use writing to support science learning and even learning in other areas of the curriculum. A kindergarten teacher who had attended two of the three Science Notebook Workshops said:

> *We had a lot of discussion about how to adapt [notebooks] for kindergarten. We came up with some good ideas that worked and were fun. It's important [for the students] just hearing the term 'notebooks.' Then they hear it again in first [grade] and second and begin to realize it's important, that they are recording what they've done and can look back on it is important. [Science notebooks] put responsibility back on the students. It helps them realize they are responsible.*

A kindergarten teacher who disliked teaching science before she participated in professional development made this observation:

> *Having the classes and being able to do it hands-on alleviated the stress. It strengthened my teaching. The science notebooking is something I use across other subjects now.*

A first-grade teacher said:

> *"The notebook classes have had a big influence on how I teach. The notebook classes made me more aware of questions to ask and that helps me be aware of what the students get and don't get."*

A sixth-grade grade teacher leader noted:

> *"I love the notebooking classes and I have taken that idea into a lot of other subjects. I use it in a lot of other areas now and it has been a really big boon to my teaching."*

Summary

The teacher interviews and classroom observations across the five years of the NSF evaluation of Gilbert's elementary science program supported the findings of this smaller, preliminary study of teachers' use of writing in science. We learned that teachers do not intuitively know how to use writing to support science learning and science as a context for practicing non-fiction writing. It is only with support from professional development that they begin to use science notebooks effectively. Indeed, the professional development offered by the NSF funded project led to higher quality learning experiences in science for Gilbert's elementary students.[6] With the end of National Science Foundation funding, the district currently does not have the funding necessary to support the release of teachers to attend the series of Science Notebook Workshops. This time of transition offers an opportunity for Gilbert to be creative in finding ways to support the science education infrastructure the district has worked hard and well to build.

[6] See *The Gilbert Elementary Science Program: Providing Students with High Quality Science*, November 2006, Inverness Research Associates