From 1987-2008, the Teacher Research program supported teachers in all subject areas as they examined how their students learn. The program considered various approaches to classroom inquiry that focused on the teachers’ observations and reflections. Throughout the year, teachers developed a research question to pursue, collected and analyzed student work related to their research question, and wrote a report of their studies. The Teacher Research Program provided opportunities for teachers to reflect on their teaching, to look at how their students learn, and to share their discoveries with other teachers. To support teachers who continue to do teacher research on their own, REEd is making the Facilitator’s Handbook available online.

Writing the Research Paper 73 - 98
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Abridged Excerpts from “Write Research to Be Read” by Donald Murray
(From Learning by Teaching, 1982, Boynton/Cook)

Note: Murray wrote this piece for academics writing educational research, urging them to write in a more journalistic, approachable style rather than a dry, academic style so that educational research would be read by a broader audience. What follows is an abridgment of six of his guiding principles.

1. You Can’t Write Nothing
   The amateur believes a professional writer writes with words, that the pro can erect a solid piece of writing out of rhetoric, grammar, vocabulary and a magic called talent. The writer writes with information. Words are the symbols for information, and if there is no information there will be no effective writing, no matter how graceful or correct the arrangement of the words on the page. The raw material from which a piece of effective writing can be constructed is knowledge—solid, specific, concrete pieces of information which can be built into meaning.

2. Write to Think
   Teachers frequently say, “Know what you want to say before you say it.” Writers know that is often false counsel. The professional writes to discover what will appear on the page. Language leads the writer toward meaning. We are all familiar with the process of talking out a problem with another person to find out what we mean and how we feel about it. The writer talks to himself or herself through writing.

3. Write in Terms of People
   The general reader is far more interested in people than in ideas, theories, or concepts. Academics may resent or deplore this, but they must accept it as a condition of work if they want to write for a general audience. Educational researchers, at least, should be comfortable writing about people, for although we need more basic research in learning, in chemical-electric brain functions, still most educational research is, by its nature, research which has direct implications for students and teachers. It should be able to be reported in terms of people.

   Writers who achieve a large audience populate their pages with individual persons whose actions reveal the ideas the writer wishes to communicate.

4. Say One Thing
   An effective piece of writing has focus. There is a controlling vision which orders what is being said. The writer writes drafts to establish the priority of meaning, and then eliminates all that doesn’t follow. In this article the dominating idea was that educational researchers could and should learn the principle of writing for a mass audience. When that idea is established, every page, every paragraph, every sentence, every word must advance it.

   A successful research project usually will give off many ideas....The tendency is to jam everything into one article. The editor experienced with reaching a large audience would advise the educational researcher to publish a series of short articles, each one developing and documenting a research finding for a specific audience.

5. Emphasize the Positive
   Inexperienced writers usually assume that the reader does not know the problem—classes are too large, teachers need retraining, there are students with learning disabilities in the classroom—and preach, telling the reader there is a problem....

   The writer will reach a large audience if solutions are presented as well as problems....Writing which attracts readers shows a problem and its solutions. It tells the reader what can be done.

6. Answer Your Readers’ Questions—Especially If You Don’t Want Them Asked
   The writer must assume an intelligent ignorance on the part of the general public. The writer believes the reader does not know the subject but is capable of knowing it. Probably the best way of anticipating what the audience needs to know is to write down the questions—the toughest questions—an uninformed but intelligent reader might ask.
   • What are the results of this experiment with using computers to teach languages?
   • Who chose the sample? Did that load the dice?
   • Is the school typical?
   • What does it mean for high school students?
   • What needs to be done now?
   • What are the problems teachers will have using the system?
   • What will it cost?

   These may not be the questions the writer wants asked, but they may be the questions an intelligent and skeptical audience will ask. The writer often finds it helpful to ask these questions during the prewriting process before the first draft.

CONTRIBUTED BY KATHY DIXON

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Audience

FIGURE 24. Austin’s Audience Wheel

### Writer-Based Prose vs. Reader-Based Prose

(Concept popularized by Linda Flower in 1979 *College English* article. Contrasting list adapted from Frederick Crews's *The Random House Handbook*.)

<table>
<thead>
<tr>
<th>Writer-Based Prose</th>
<th>‘</th>
<th>Reader-Based Prose</th>
</tr>
</thead>
<tbody>
<tr>
<td>exploratory, concerned with discovering what one wants to say</td>
<td>‘ purposeful, concerned with communicating experiences and/or ideas or viewpoints</td>
<td></td>
</tr>
<tr>
<td>audience = primarily the writer</td>
<td>‘ audience = primarily readers</td>
<td></td>
</tr>
<tr>
<td>parts or whole relatively undeveloped</td>
<td>‘ relatively developed throughout</td>
<td></td>
</tr>
<tr>
<td>organization or structure associative</td>
<td>‘ organization or structure logical</td>
<td></td>
</tr>
<tr>
<td>contexts assumed</td>
<td>‘ contexts supplied</td>
<td></td>
</tr>
<tr>
<td>evidential basis for ideas assumed</td>
<td>‘ evidential basis for ideas supplied</td>
<td></td>
</tr>
<tr>
<td>interest in subject assumed</td>
<td>‘ interest in subject created through rhetorical features of the writing</td>
<td></td>
</tr>
<tr>
<td>language imprecise and unclear</td>
<td>‘ language precise and clear</td>
<td></td>
</tr>
</tbody>
</table>

CONTRIBUTED BY KATHY DIXON
From First Draft to Last:  
Deepening the Research and Making it Accessible

Following are two drafts of a research study written by Sam Brewer. The first version of his paper represents his first draft and was turned in after his first year of research. The second version represents the final draft, after a second year of deepening the research and revising and editing the paper for publication.

These two papers offer an opportunity for teachers in your groups to compare the two drafts considering how it changed, organization, how he accessed and showed the data, etc. We suggest an entire Teacher Research meeting be devoted to reading these two papers and discussing their evolution.

DRAFT (original)

Fitting Science into the New 4th Grade Curriculum
By Sam Brewer
June 2000

I. Unexpected Insight

"I like science." Cassie caught me a little by surprise with this statement. She dropped by my room during lunch hour as I was catching up on paperwork.

"Why do you like science?"

"Because," she responded, "When we do science, we always learn something new."

For me this statement was an epiphany. Cassie explained (as only children can) what I have tried to understand for the past two years … Why science education is useful and important in the K-6 classroom. Cassie continued with confidence to recount some of the science concepts we’ve covered this year.

II. The View from the Office

During the last two years my school district has adopted reading and math programs that are expected to bring students to grade level standards as measured by the SAT 9 test. These programs, Open Court and Saxon Math have proven to be very effective at improving reading and math skills in the elementary grades. Implementation of each program has been strictly monitored by the district’s administration through regular testing. Administrators and reading coaches observe and enforce strict time blocks that must be dedicated to Reading, Language Arts and Math. Student test scores are collected and published. Scores are distributed at school comparing teachers. The current superintendent and school board use interlocking puzzle pieces to illustrate their plan for improving student achievement.

III. The Schedule

Were I to apply this puzzle model to the K-6 curriculum, there would be two main pieces - Reading and Math. At my school site the science piece of the puzzle has been left out completely by most teachers, and difficult to fit into the curriculum by those who wish to include it. Science is viewed as a diversion from the learning of basic skills. As the science subtest is not currently required for students to take for the SAT 9 test, it is not deemed relevant for elementary school instruction.

It is, therefore, against the wishes of my administration to teach science. Our school day runs from 8:10 a.m. to 2:10pm. Lunch and recesses take up roughly 55 minutes of each day. This leaves five hours for instruction. Our Open Court Reading time block is 2 1/2 to 3 hours. Our Saxon Math time block is 1 hour and 20 minutes. Spelling instruction takes roughly 20 minutes per day. After these 4 hours and 10 minutes - roughly 45 minutes remain in the day for P.E., Art, Music, Social Studies, Silent Reading … and Science.

To describe the school day of a ten-year-old as five hours of uninterrupted productivity would be to exaggerate. We attempt to use our time efficiently, but certainly portions of the school day are consumed by subject transitions and normal interruptions. In other words, the 45 minutes I’ve budgeted after Reading, Math and Language Arts is not 45 minutes. The K-6 teachers at my school had to sacrifice some subjects in order to realize the district’s language and math objectives. For most, cutting science was a logical way of balancing the time budget. In my view cutting science would be too costly. I have seen since my training in the Sacramento Area Science Project (1992) the positive effects science learning has on young children. I believe that science activities are conduits. Students can make personal connections and learn beyond the classroom with a stimulating science curriculum. Students who have science experiences in class find connections in their reading and writing. Math suddenly seems more useful when
students need it to measure a rock, set up circuit board or record physical changes over time. This learning generates something in the mind that Cassie describes as "new." Certainly, however, Language Arts and Math have "new" topics

IV. Questions

I brought Cassie's statement to the staff lounge and asked the teachers available to respond to the first portion of this paper. A couple of teachers grumbled approval and returned to their sandwiches. I struck a dissonant chord with another, however. She argued that children had the opportunity for new learning in math and language arts each time a concept was introduced. She took the example of metaphor. Metaphor, she argued, is a literary tool students can attain through instruction as something "new." I gave this some thought and greatly appreciated my colleague's willingness to respond. I believe that science learning is a tremendous source of metaphor. Metaphor is an association or connection. I have seen students make substantive associations and connections in science class. Whether science is the wellspring of metaphor or not is the topic of another essay, however. Cassie and her classmates enjoy science. They want science activities. This leads then to the essential research question I began the year with...

Can I include whole class science units (science lessons and activities) on a regular basis in my school week? My conjecture initially inclined toward fulfillment of this ambition. Of course I could include more science instruction I could find a way to build science into my language arts and reading curriculum. No sweat.

V. The Year - Plan and Action

My ambitions were met with various unavoidable circumstances. Our new math adoption not only increased the amount of time spent on math. The reading curriculum arrived with increased objectives and strict scheduling. Also, this was a year I was scheduled for evaluation by the principal. This meant frequent observations and reminders to stay the course in reading and language arts.

Despite the Distractions

I developed a plan that included FOSS science units into 012en Court Reading Units. My aim was to be able to do science that could be called Reading. The Reading and Science units are as follows:

Reading Unit Concepts | Foss Science Kits
1. Risks & Consequences (Sep-Oct) | 1. Ideas and Inventions
2. Business (Oct, Nov, Dec) | 2. The Human Body
3. Medicine (Jan.,Feb) | 3. Earth Materials
4. Survival (March, April) |
5. Colonial Life (May, June) |

During the first month of school I stressed social studies during our 45 minute elective block. This seemed to fit most effectively with our Risks and Consequences unit. Geography and archaeology were the focii of our social studies. After the students had a chance to get acquainted with California’s physical geography we started a science unit called Ideas and Inventions. This Unit introduces students to creative aspects of scientific process. They had a chance to invent games based on leaf rubbings, carbon printing and chromatography. We built periscopes, arranged mirrors to achieve multiple images, and wrote mirror messages. The students enjoyed these activities and looked forward to them. I have a very active group this year, and they seemed much more calm during science that they were otherwise in the day some of the students took it upon themselves to make very elaborate board games with intricate rules.

We didn't have time for as much discussion, exploration, experimentation and "constructivist discourse" as I like and have traditional enjoyed. The 45 minute block of time squeezed some of the thinking out of our lessons. I felt that much energy was expended trying to set up, do, and clean up the activity. I was afraid students hadn't truly processed the science we had done. I noticed, however, great improvement in the overall comprehension, (as measured by our standard tests) vocabulary and language arts during our Business unit. Last year, my first with Open Court, I didn't do the Ideas and Inventions Unit, and my students really seemed bored and out of touch with our Business Unit. This year's students were able to see applications of their own inventiveness in the Reading. Students who invented games explored ways of marketing, patenting and selling their products for profit. Suddenly a unit that had been relatively dull had some life.

This enthusiasm transferred easily to the Research the students were doing. Open court has a research model for students to follow that encourages students to develop questions based on their own curiosity about a concept being studied. These questions are followed by theories - and - eventually fact finding. I encouraged students to pursue questions about a business that interested them. I asked them to consider ideas and inventions in their research. The results were excellent. A boy who has limited interest in school prepared questions and interviewed the gruff proprietor of the ice cream shop where his sister works. He played the tape of his interviews for us and made a poster describing how to earn a profit from a scoop of ice cream. A whole group of students contacted the Lego Company and found out how Legos are made. Each researcher pursued a business directly related to their own interests. Consistent in their findings was the importance of useful ideas and hard practiced work. Successful businesses had products to
which people were loyal and courteous communication. I feel that this year’s class with the science unit did better that last year’s, not only on multiple choice, but in essay and discussion as well.

   Medicine followed Business in our schedule. As with Business, medicine is a dull topic when viewed solely in the pages of an anthology and skill book. It’s difficult to sympathize with 14th century victims of the Black Plague or a gored bullfighter with an exposed femur, if this information exists as part of a reading skill diet. Again the science unit elevated the awareness of issues delivered in the text. We learned the names of each of our main bones, and made and manipulated models of fingers and legs. We immobilized joints and attempted various everyday tasks. Each of these tasks helped students empathize with story characters, visualize setting, and track and develop paragraphs. Students could eventually identify bones from other creatures. I brought to class a horse skeleton and mouse pellets. Students received a certificate upon memorization of their own bones. They seemed intent on mastery, and became really confident when they could then know the scapula of a horse and a mouse. This confidence carried over to their reading. For some, however, the reading remained largely a frustration. The connections to -mice and horses are what I think Cassie was calling “new”. This was new and exciting. These kids are told regularly by principals, superintendents, parents, teachers, and newscasters how important it is for them to read well enough to score well on standardized tests. They have book, page, chapter and word logs they feed into a general fund so that the principal will enter a snake pit, kiss a pig, or paint themselves green. It’s encouraging to know there’s a subject available that can stimulate learning without the image compact we’ve developed. Students can observe to observe. Rather than produce an acceptable response, a student can absorb some knowledge they can bring with them through life.

   We took a trip to Sac State, and as a wrap of our study of skeletons visited the “Bone Room”. I think the official designation is Science 115. There on display were a hundred skeletons of various animals - a veritable feast. After an enthusiastic perusal we generated questions and theories. Why does an alligator have such a small pelvis? What happened to the dolphin’s arms?

   We returned to school and began preparing for the SAT 9 test. The better portion of our year has been spent preparing for this test, but the couple of weeks preceding the test were spent mainly on multiple choice test strategy. Enough said.

   After two weeks of ‘SAT 9, we’re somewhat back to normal. We’ve begun a FOSS unit entitled Earth Materials. I haven’t been able to make a connection between the scratch test, crystal growth, and Colonial Life, but I’m holding out hope. The last month and a half of school seem a supreme anti climax. What do we do now? The accountability model places so much emphasis on the test that we’re unmotivated without it. It’s not relaxed at school. It’s simply without a purpose, a goal. In the past I recall entering a new phase in the waning weeks, and feeling disappointed when the year ended. Absent for me, and I perceive, for other teachers and students, is the drive of the learning process. I find that placing all educational energy on two subjects tested for two weeks in May ignores the process of learning.

VI. What Happened?

   I look back on this year with tired eyes. I have seen as I expected that children can and will make the best of any classroom situation they encounter. Together we did everything we were supposed to and some of what we weren’t supposed to - science. I know there are those with whom I would disagree as to the existence of science in the Open Court Reading lessons. That argument, however, was not my purpose in research. I wanted to know if I could teach science under the conditions I described. In theory I could. In reality I could not as well or as much as I wanted or my students needed. At year’s end I sit disappointed with the lack of time I’m able to have for science. Ten year old children in an urban environment have little enough in the way of concrete scientific inquiry.

   I recently polled the K-6 teachers at my school as to how much science they teach. Most have cut it out completely. A couple told me they were given instructions from their reading coach to not teach science. Science is viewed as educational contraband. As such, that notion cannot but have a constraining effect on any science instruction that occurs.

   I am encouraged by the improvement in reading ability by many students in our district. Participating in teacher research this year has provided me with unexpected insight. My district’s administration has aggressively proclaimed that students will realize greatest academic achievement through reformation of instructional materials, methods, and assessment. They’ve set extremely high Benchmarks to be attained within a given time period. As a result tremendous pressure to meet these expectations has squeezed much of the creativity out of the K-6 classroom. I state this not as a complaint. Whether I like it or not, creativity is currently viewed as a distraction from demonstration of grade level status as expressed by the SAT 9.

   As much as I admire its intentions, I can’t see success in my district’s course. The district and the board have tearfully praised themselves for their efforts at leading Sacramento’s youth from the academic desert. Their standards are unrealistic and narrow, however, students need a balanced curriculum that includes science, music, P.E., art.

   I discovered in my research that having unrealistic goals is a flaw in my own position. I believed that I could have my students do Reading, Math and Science. I was wrong. I did some science: inefficiently. My colleagues who have dropped science altogether are probably more realistic that 1. I will, however, continue to try. I have to for those students like Cassie, who want something new to kindle the imagination.
Part I: Science as Contraband

Unexpected Insight

“I like science.” Katie caught me a little by surprise with this statement. She had just dropped by my room during lunch hour as I was catching up on paperwork.

“Why do you like science?”

“Because,” she responded, “When we do science we always learn something new.”

For me this statement caused an epiphany. Katie explained (as only children can) what I have tried to understand for the past two years—why science education is useful and important in the K-6 classroom. Since my training in the Sacramento Area Science Project (1992), I have seen repeatedly the positive effects science learning has on young children. Science activities are conduits; with a stimulating science curriculum, students can make personal connections and learn beyond the classroom. Students who have science experiences in class find connections in their reading and writing; math suddenly seems more useful when students need it to measure a rock, set up a circuit board, or record physical changes over time. In my research over the last two years I have tried to look more closely at these positive effects. My first year of research was more a matter of proving that I could survive the assault that implementing Open Court posed to my teaching. In my second year, through careful examination of student responses and student work, I was able to document some of the profound reasons why science learning is so important and useful. This learning generates something in the mind that Katie describes as “new.”

The View from the Office

Two years ago, in order to bring students to grade level standards as measured by the SAT 9 test, my school district adopted reading and math programs, Open Court and Saxon Math, which have proven to be very effective at improving reading and math skills in the elementary grades. Implementation of each program has been strictly monitored by the district’s administration through regular testing. Administrators and reading coaches observe and enforce strict time blocks that must be dedicated to reading, language arts and math. Student test scores are collected and published, and scores comparing teachers are distributed at school.

The current superintendent and school board use interlocking puzzle pieces to illustrate their plan for improving student achievement. Were I to apply this puzzle model to the K-6 curriculum, there would be two main pieces—reading and math. At my school site the science piece of the puzzle has been left out completely by most teachers and is difficult to fit into the curriculum by those who wish to include it. Science is viewed as a diversion from the learning of basic skills. As the science sub-test of the SAT 9 is not currently required, science is not deemed relevant for elementary school instruction, and it is, therefore, against the wishes of my administration to teach science.
The View from my Classroom

Our school day runs from 8:10 a.m. to 2:10 p.m., with lunch and recesses taking up roughly 55 minutes of each day, leaving five hours for instruction. Our Open Court Reading time block is two and a half to three hours; Saxon Math takes 1 hour and 20 minutes, and spelling instruction, roughly twenty minutes per day. After these four hours and 10 minutes, roughly 45 minutes remain in the day for P.E., art, music, social studies, silent reading... and science.

To describe the school day of a ten-year old as five hours of uninterrupted productivity would be to exaggerate. We attempt to use our time efficiently, but certainly portions of the school day are consumed by subject transitions and normal interruptions. In other words, the 45 minutes I’ve budgeted after reading, math and language arts is not 45 minutes. The K-6 teachers at my school have had to sacrifice some subjects in order to realize the district’s language and math objectives. For most, cutting science was a logical way of balancing the time budget. In my view, however, cutting science would just be too costly.

Could I manage to include whole class science units (science lessons and activities) on a regular basis in my school week? Of course I could include more science instruction. I could find a way to build science into my language arts and reading curriculum. No sweat.

However, my ambitions crashed into unavoidable obstacles: the new math program only increased the amount of time spent on math, and the reading curriculum arrived with increased objectives and strict scheduling. Also this year I was scheduled for evaluation by the principal, which meant frequent observations and reminders to stay the course in reading and language arts.

Despite the Distractions

In order to do science that could be called reading, I developed a plan that included FOSS science units into Open Court reading units:

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<td>5. Colonial Life (May-June)</td>
<td>Earth Materials</td>
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During the first month of school I stressed social studies, especially geography and archaeology, during our 45 minute elective block as this seemed to fit most effectively with our Risks and Consequences unit. After the students had a chance to get acquainted with California’s physical geography, we started a science unit called Ideas and Inventions, which introduces students to creative aspects of scientific process and gives them a chance to invent games based on leaf rubbings, carbon printing and chromatography. We built periscopes, arranged mirrors to achieve multiple images and wrote mirror messages. Some of the students (including Katie) took it upon themselves to make very elaborate board games with intricate rules. The students enjoyed these activities and looked forward to them; an active group, they seemed much more calm during science than during any other time. The activity format in other core subjects involved extracting materials (book, pencil, workbook) from their desks and following a script, led by the teacher, which usually required focus on written directions and individual practice. Appealing mostly to a linguistic learner, this routine did not suit some individuals; in fact, it constrained them. In science class they were able to get out of their seats and stand or work sitting on the floor. Their materials came not from their desks but from a communal kit. With more freedom for students to move, interact, and improvise, tensions eased considerably.

We didn’t have time for as much discussion, exploration, experimentation and “constructivist discourse” as I would have liked and have traditionally allotted. The 45 minute block of time squeezed some of the thinking out of our lessons. I felt that much energy was
expended trying to set up, do, and clean up the activity, yet I was afraid students hadn’t truly processed the science we had done. I noticed, however, great improvement in the overall comprehension (as measured by our standard tests) in vocabulary and language arts during our Business unit. Last year, my first with Open Court, I hadn’t done the Ideas and Inventions unit, and my students had really seemed bored and out of touch with the content. This year’s students were able to see applications of their own inventiveness in the reading. Students who invented games explored ways of marketing, patenting and selling their products for profit. Suddenly a unit that had been relatively dull had some life!

This enthusiasm transferred easily to the research the students were doing. Open Court has a research model for students to follow that encourages them to develop questions based on their own curiosity about a concept being studied, then to formulate theories, and eventually to fact-find. I encouraged students to pursue questions about a business that interested them and to consider ideas and inventions in their research. The results were excellent.

- A boy who has limited interest in school prepared questions and interviewed the gruff proprietor of the ice cream shop where his sister works. He played the tape of his interviews for us and made a poster describing how to earn a profit from a scoop of ice cream.
- A whole group of students contacted the Lego company and found out how Legos are made.
- One student reported on a humble breakfast diner she attends every Saturday with her grandfather; after thirty years, the proprietor still makes only enough money to “make another breakfast” for her customers—a fact which punctured the class assumption that greed motivates all sales.
- Another student reported on a sports store that went out of business shortly after he visited for an interview.

All researchers pursued a business directly related to their own interests. Part of each student’s poster presentation was a question and answer session followed by open discussion focusing on the reasons for the success of the business presented. Afterwards, as a class, comparing and contrasting all the different successful and unsuccessful businesses, we formulated a theory of success in business that included four key traits: (1) the importance of useful ideas, (2) hard work, (3) products to which people were loyal, and (4) courteous communication.

I feel that this year’s class with the science unit did much better than last year’s without it, not only on multiple choice unit tests, but also in essay work and discussions. When we simply use the text, it’s a great task to get most students to attend to essential reading and writing elements like setting and character development. When they go out to real settings to meet real characters, the “work” disappears. Student researchers enter businesses with a purpose beyond purchase; they go as learners and reporters, determined to bring something of value for their peers. For most, the experience transforms the acquisition of knowledge of subject matter into more of a game of sharing and trading information.

Medicine followed business in our schedule. As with business, medicine is a dull topic when viewed solely through the pages of an anthology and skill book. It’s difficult to sympathize with fourteenth century victims of the black plague or with a gored bullfighter with an exposed femur (characters in our Open Court readings) if this information exists only as part of a reading skill diet. My students didn’t even know what a femur was! Again the science unit elevated the awareness of issues delivered in the text. We learned the names of each of our main bones and made and manipulated models of fingers and legs. We immobilized joints and attempted various everyday tasks. Students received a certificate upon memorization of their own bones, and they seemed intent on mastery. Eventually, students could identify bones from other creatures; when I brought to class a horse skeleton and owl pellets, they became really confident when they knew the names. For some this confidence even carried over to their reading; for some, however, the reading remained largely a frustration.

Finally, we took a trip to CSU-Sacramento, and, as a wrap-up of our study of skeletons, visited the “Bone Room”; there on display were a hundred skeletons of various animals—a
veritable feast! After an enthusiastic perusal we generated questions and theories. *Why does an alligator have such a small pelvis? What happened to the dolphin’s arms?*

Then, unfortunately, we returned to school and began preparing for the SAT 9 test. The better portion of our year had been spent preparing for this test, but the couple of weeks preceding the test were spent mainly on multiple choice test strategy. Enough said. After two weeks of SAT 9, we returned somewhat to normal, beginning a FOSS unit entitled Earth Materials—even if I hadn’t yet been able to figure out a connection between the scratch test, crystal growth, and Colonial Life. The last month and a half of school seemed a supreme anticlimax. In the past I recall entering a new phase in the waning weeks and feeling disappointed when the year ended. However, the accountability model places so much emphasis on the test that we’re unmotivated without it, lacking purpose and goal. Placing all educational energy on two subjects tested for two weeks in May ignores much of the process of learning. What were we to do now?

**What Happened? Evaluating My First Year’s Experiment**

I look back on this year with tired eyes. I have seen as I expected that children can and will make the best of any classroom situation they encounter. Together we did everything we were supposed to do and some of what we weren’t supposed to do—science. Could I teach science under the conditions I’ve described? In theory, I could; in reality I could not as well or as much as I wanted or as my students needed. I did some science: inefficiently.

I recently polled the K-6 teachers at my school as to how much science they teach. Most have cut it out completely. A couple told me they were given instructions from their reading coach to not teach science. In our district, science is viewed as educational contraband, a notion that cannot help but constrain any science instruction.

I am encouraged by the improvement in reading performance of many students in our district. My district’s administration has aggressively proclaimed that students will realize the greatest academic achievement through reformation of instructional materials, methods, and assessment. The district and the board have tearfully praised themselves for their efforts at leading Sacramento’s youth from the academic desert. They’ve set extremely high benchmarks to be attained within a given time period. However, as a result, the tremendous pressure to meet these expectations had squeezed much of the creativity out of the K-6 classroom; creativity is currently viewed as a distraction from demonstration of grade level status as expressed by the SAT 9. As much as I admire its intentions, I can’t see success in my district’s course of action. Students need a balanced curriculum that includes science, music, P.E., and art.

**Between Years: A New Resolve and A Research Focus**

Abandoning science altogether would be easy enough. I’m pressured to eliminate it from the curriculum and am given a lifetime supply of thaw and serve reading and math lessons with which to fill the school day.

But I can’t leave out science because of the eloquent responses to science lessons students have made. Science class will continue for students who hate school for the most part but bring in examples of experiments they’ve tried at home. It will continue for students who find a strict regimented framework for learning unbearable. In science class students from diverse backgrounds find common ground and a level playing field. Ten-year old children in an urban environment have little enough in the way of concrete scientific inquiry. Students whose present home life is unstable and for whom the relevance of reading and writing skills practice is lost often find themselves in science. As a teacher I can’t ignore this. I’ve seen too often the rigor of school make itself sensible and useful in science class, often to kids who are labeled as the most “hard to discipline” or troubled. I see this in their eyes and facial expressions during experiments. I hear it in the retelling of some project result (success or failure). I read it time and again in student samples enlivened and delivered in a confident style. We have
empowered many children with basic reading, writing and math skills. Some of the skill gap that divides students of economic advantage from those whose families are struggling to survive is shrinking. However, what these children show me is that basic skill development by itself isn’t enough. They don’t always see the connection between what they read and write and why they read and write. That connection is more apparent to students of academic and economic advantage, who readily see evidence of profit from education at home and have a notion of what they might do with their education in the future. Science class exists for my students as a common ground for observing the way things work, deciding which of these things is important, and using reading and writing skills to learn more about what’s important to them. Can I ignore a subject that makes a student a more confident learner? I think not.

However defeated I felt after my first year’s experiment, I have thus vowed to continue to try to integrate science into the required curriculum. I have to, for those students like Katie, who need and deserve something new to kindle the imagination. And I have vowed as well to look for evidence I can share with others of how much science helps kids to learn.

Is a child’s appetite for learning observable? Is it measurable? When a child is allowed a chance to manipulate a question, cast out a guess as to its answer and fumble about with materials that address the question, does that child receive academic benefit? I vowed to collect evidence that demonstrates that the answers to these questions are in the affirmative. I know that it is a child who feels secure and confident in an academic setting who develops the healthiest appetite for learning. I would find evidence that demonstrates this appetite—particularly among children for whom schoolwork has presented the anxious gloom of uninterrupted struggle. I would also find evidence that shows science activities as able and swift conveyors of concrete reading and writing skills.

Part II: Students Come to Science’s Defense—“You Can’t Make a Light Bulb Glow in Spelling”

Buoyed by my firm resolve and determination to document the importance of science-learning, I began this last year with hope and vigor. My fourth grade teaching-partner and I developed an afternoon schedule whereby we exchanged students for social studies and science on Tuesdays and Thursdays from 1:20 p.m. – 2:15 p.m. With the regularity of a Mambo dance step, all fourth graders returned twice a week to science class where they conducted experiments with school supplies, extracted knowledge about themselves from hairy owl pellets, and lifted heavy metal with an iron core wrapped in wire.

By April, the 4th graders had completed units involving Wetlands, Ideas and Inventions, and Electricity and Magnetism. Our planned exchange proceeded without interruptions throughout the year. Compared to students from the previous year, my students had as much or more science. My colleague’s students would not have had science were it not for the exchange.

The exchange worked well on various levels. I got to know my colleague better and planned more with her the coordination of instruction and field trips. The 4th graders as a whole became a more integrated unit as they shared experiences and teachers. This hadn’t occurred previously in our self-contained model. I also felt that classroom management was easier than it had been previously when I was alternately teaching language arts and science to my own class. I know part of the reason for a smoother school week for me was the exchange. Another part was the science lesson. I felt like I could relax a bit and guide exploration during science.

Buoyed by this success, I was curious as to my students’ personal views of science and the kind of learning that happens in science. I asked two questions: 1) What do you like about science; and 2) How is learning different in science class than it is in other subjects? I gave them
some minutes to talk about the questions and as much time as they wished to write responses. My assumption was that their responses to the first and easier question would weigh heaviest. For a student to describe positive characteristics of something seemed to me much easier than making a more complicated comparison of science to learning in other subjects. To my surprise, responses to the second question were dominant. In fact, some students decided to reverse the order of their responses.

My initial reading of the student responses was uninspiring. A few responses stood out for their clever insight, but most seemed to read in a predictable, mainly positive mood. Some months later I undertook a more careful reading. With the volume of student work I regularly receive, I don’t budget much time for analysis. Now, without pressure to grade and respond, I took time to read and reread, looking for significant data, and discovering concrete student observations about science lessons and what learning they received from science class.

What surprised me when I grouped the papers was that they did not conform to my initial assumptions. I had planned to group the papers by general academic ability, but this plan unraveled as papers clustered about themes. In fact, the ability group model proved irrelevant for analysis. Science class made as much sense to students for whom academics is agonizing as it did for students who really dig school.

Six distinct themes emerged from their responses to the two questions:
1. Many children found the physicality of science crucial to their learning;
2. Some described the subject itself as inherently interesting and fun;
3. More than a few enjoyed the scientific method—the process of theory-making;
4. Others chose to describe cooperation as important and distinct in science;
5. Another group linked science class to study or work in the future;
6. Many students saw for themselves a clear distinction between science class and other subjects.

A fuller account of their comments on each of these six themes follows.


Many of the children clearly enjoyed the kinesthetic nature of science class and praised the opportunity to actively do, to be the agent that makes something happen. Polly is a strong imaginative student with a current organizational challenge. It’s often I saw the blush of embarrassment as she looked for a math or spelling paper or forgot to do something. Science gives a safer haven right now for Polly’s imagination than math and spelling homework. She writes, “You can learn how the body works rather than learning to multiply 2.85 x 8.4. Science is different because we can make motors work, or volcanoes blow, or something like that. Math is different from science because you can’t make numbers float in the air and stuff like that.” The exuberance of her verbs seems to capture the joy of creation she feels in science.

Peter likes to do well in school, and does writing assignments quickly, as if to end them, but he actually wrote a lot in his defense of science: “I like that you are doing something fun but your learning. It’s different from other subjects, because you get into it easier than other subjects. Also, you can’t make a light bulb glow in spelling. Also can you learn to name you bones in Social Studies? Also can you make colors change in Math? Can you learn about blood streams & nerves in P.E.?”

Having been chastised much at school and at home for a perceived lack of attentiveness, Jake remains remarkably upbeat, but suffers to complete math and writing assignments neatly. He expresses pride in his learning accomplishments in science: “I like science because I learned some of my bones and learned how to turn on a light bulb with a battery and wire and a light bulb of course (.) it was fun then I also learned something about magnets (.) if you have the magnet just turn one the other way around one will go to the side(.”

Although Fred is articulate and succinct, a fine motor challenge makes writing a tiring chore and puts cursive out of the question. Not surprisingly, he appreciates the chance to “do”: “I like doing stuff physically instead of…not….like plugging in a light bulb.”

Shawn likes dirt bikes, football and skateboards. He works hard in school, but resists reading for pleasure. However, he does like to construct things and did a report on auto
mechanic work for his business research. Of Science, he claims excitedly: “We get to make a light bulb work, and make a motor go.”

Mary sums up the kinesthetic argument quite well: “Learning in science is different that other classes because the children get to actually do the experiments. Unlike in writing or spelling the children only write on paper… Or like in Reading, students read about expeditions or famous experiments. But in science, students get to do the experiments, if they’re safe to do that is.”


Emma is a quite outspoken, and unafraid when it comes to making critical observations. In fact, she’s blunt: “Learning is different in science because I think kids pay more attention… it’s more interesting than other subjects.”

[3] **Scientific Thinking: “A Great Challenge You Have to Solve”**

Some students value the scientific process of open exploration. Matthew, a bilingual Spanish/English student with a solid work ethic, explains: “Science is different from Spelling because in Spelling there are instructions. In science you don’t have to use a pencil you only use your hands. I really like the experiments that we do.” Matthew values the unpredictable outcomes of science class. He is willing to “do,” “try,” and “want it to work,” knowing that with his hands and his academic skills he’d learn in the end through a process that was different from the scripted language format of his other subjects: “I also like science, because it’s a great challenge that you have to solve. I really like the challenges. When you try an experiment you want it to work, but you can’t.”

Mary, too, commented on the joys of scientific inquiry: “In Science, I like to do the experiments and then afterwards, I like to compare the answers with my theories. Then I can see a difference between them and that’s how I learn in science…”

Although Alena struggles mightily with reading and math skills, she generally tries to conceal her skill needs and is reluctant to be selected for extra help in fundamental skills. Science appeals to her sense of independence and offers her the joy of invention: “It (science) is different because you can try it by yourself and you can invent lots and lots of things.”


Capp, an active, gregarious, athletic child who would much rather run than write, is very loyal about school work, but it does pain him. He praises both the active and collaborative parts of science: “It is different than other subjects because it is more fun and you get to do the project with someone in your group. It’s also different because you get to do stuff that you wouldn’t yousahly (usually) do in school.” Kathy, too, enjoyed working with others: “Science is having fun, learning, and helping others doing the projects.”

[5] **Future Use: “All We Learn in Science Could be our Future Job”**

For Taylor school has become a succession of scrutinized steps. His are not always on the path of grade level skill. He is told this, and the pressure is evident in his body language as he goes from one math, writing or reading assignment to the next. As redundant as the corrections are presently in spelling, math, and reading, Taylor excels at manipulating materials and solving physical problems in science. Science is useful for him. He sees hope in its utility. Taylor is in fact proud of his success in science: “I like science because you can yous battery and wires and have lots of fun. You can learn about bones (bones) and Idus (ideas) and invenches and you can make a new invenchen and it might be usfal in the fucher (future).”

Kristina, too, praises this usefulness: “I like it because we do science every week. In the future we will no how to do science.” Pedro, an English Language Learner, makes this even more specific: “Also science is different because in science you get to learn about bones and when you go up you meet know how to heel people.”
Talia, whose mother emigrated from South Africa to work as a nurse, made one of her first home-school connections when she linked what we were studying to her mother’s job: “We are seeing what we can be in the future like we learn about bones so we can be a doctor or a nurse all the things we learn in science could be our future job... In Africa I never did science so I think it is fun and exciting even though I don’t know how to name my bones.”


Many students don’t even perceive science as work. Amanda says: “I like science more better because you don’t have to lots of work and its really cause it teaches you kinds of things... Science is different from math because you can’t write in your book and you have math for homework and science don’t have to do it for homework. Spelling is different because you have to learn the words and spell them but science you don’t have to spell any words.” As her teacher, I know she actually does write in her book—her journal—in science, and that she has science homework where she has to spell some complicated terms correctly. However, she just doesn’t register this as “work.” Jane is more aware of the reading and writing in science: “Science is different because we get to work with stuff instead of reading but we have to read sometimes and write... I like doing the experiments but I hate writing.”

Madison, a dutiful student, rarely seems enthusiastic about learning or regards learning as something other than a task. But science to her is clearly no task: “I like science because I like trying experiments with things that you have in your everyday life. In science you don’t work, you have fun. I like science because people get to have the fun of knowing you invented something that is why I like science.”

Eileen even made a chart to illustrate what she perceives as differences between science, math, reading, spelling, and other subjects like social studies:

<table>
<thead>
<tr>
<th>Subject</th>
<th>activity</th>
<th>nothing in common</th>
</tr>
</thead>
<tbody>
<tr>
<td>math</td>
<td>thinking</td>
<td>no experiments</td>
</tr>
<tr>
<td>reading</td>
<td>predicting</td>
<td>no experiments</td>
</tr>
<tr>
<td>spelling</td>
<td>spelling and learn words</td>
<td>no bone names</td>
</tr>
<tr>
<td>social studies</td>
<td>studying and identifying</td>
<td>no experiments</td>
</tr>
</tbody>
</table>

Mariposa sees the repetitive nature of activities in more scripted lessons: “Learning is different than in other subjects because in science you get more ‘into it’ than some other subjects. Also in things like in math you pretty much do the same thing each problem set. But with science you can learn almost everything to know about the earth and my favorite thing, nature. (I really like nature!!)” Anna agrees: “It’s also different because for example (language arts) skill pages are very different from science.”

In their book Classroom Instruction that Works, Research Based Strategies for increasing Student Achievement, Marzano, Pickering and Pollok present strategies which, when used effectively, demonstrate significant improvement in achievement as measured by standardized tests. These strategies include “Identifying Similarities and Differences” (Chapter 2), “Cooperative Learning” (Chapter 7), and “Generating and Testing Hypotheses” (Chapter 9). As evidenced in their own testimonies, providing a varied curriculum that includes science offered my students a chance to articulate differences and similarities in a substantive manner, to form productive collaborations with one another, and to engage in the critical thinking involved in theory-making. The vital links science activities provide to concepts covered in similar and different courses help students feel comfortable freely manipulating these concepts.

Students are also proud of the skills they gain in the scripted skill development lessons, but what do they do with them? Science is one of many opportunities children have to flexibly assemble the various colors, shapes and motions of their required knowledge and invest their own meaning into them. The outcome is as wondrous as their chance at childhood. We can, as teachers in our awkward way, establish a practical setting for this achievement. In fact, within this stimulus-rich setting, children may even develop more fully their complete language skills.
Part III: Science as Catalyst for Reading and Writing Skills

Could science in the elementary classroom improve writing, reading and math achievement? Could data be collected to support the teaching of basic academic skills in science class? Although I didn’t begin the year with these questions, the more carefully I looked at student work produced after science class, the more clearly I began to see a connection between science learning and improvement in language arts skills.

Explaining a Process: “This Is How Electricity Works!”

I am charged with teaching writing skills that meet academic performance standards, including multi-paragraph responses to literature, summaries, persuasive prose, and description of a sequential process. Writing is scored against up to 40 distinct writing skills taught to the student during a reading and writing unit, and these scores are collected by the district curriculum office and the site administrator roughly every six weeks.

The delivery of a regimented reading, writing, and language arts program has its benefits. The literature contains excellent examples of skills to be mastered. Skill lesson preparation is simplified by means of ample and specific teacher plans and student practice pages. Students become very familiar with the structure of written language from sentence to paragraph, to story and essay. I find the skills emphasized by Open Court to be essential for developing readers and writers. Students develop the ability to read and write coherent paragraphs, perform complicated punctuation, and identify and use descriptive language for a wide variety of purposes.

But science class can make basic skill development an easier, more profound proposition than administering strictly a literature or text based approach. It is in writing for science that my students find the strength to carve a much deeper furrow into their own thinking than they do when they simply present what they think I want to read. Writing about science, excited by its content, my students extend their efforts at communication so they can convey an idea they’ve developed to a new reader. Their enthusiasm gives them the patience to organize and revise the product.

For example, I asked my students to describe electricity using as a basis for description the activities (mainly FOSS Electricity and Magnetism) used in class. Students were asked to describe electricity as they observed it in activities involving a battery, wire, various household objects, a small electric motor, and a light bulb. The writing they produced meets two important writing standard criteria: 1) Paragraph writing and 2) Using time and order words to describe a process. What impresses me about the result is the success of students who often struggled with the more hypothetical Open Court exercises and prompts. These students effectively use the Open Court writing skills to represent a process that they have actually witnessed in science class. Students were expected to write one paragraph, but many chose to write more than one. Six brief portraits of students and samples of their work follow.

Madison, the dutiful student mentioned above, usually does what she’s supposed to, but a series of let-downs in life have given her a hard edge, so it’s sometimes difficult to get her to buy into instructions, to be enthusiastic about learning, or to see learning as something other than a task. For this assignment, Madison’s paragraphs are highly visual. The first paragraph includes an effective comparison (electrons and ants). The second paragraph begins (imperfectly) with a topic sentence and follows with sentences that develop the main idea. What makes her paragraphs compelling is the apparent regard for the reader and her desire for the reader to learn something (see Figure 1).

An English language learner and an extremely quiet child who doesn’t like to have attention brought to issues of English comprehension, Min tries very hard to produce what the teacher wants and do what the other students do. Indeed, she tries so hard she often uses excessive verbal volume to cloak the minimal substance resulting from her lack of comprehension. I vividly recall a math story problem that gave her silent agony.
Given this cautiousness, I was pleased that in Min’s description of electricity she reveals independent investigation as well as some confidence in describing what she experienced (see Figure 2).

Taylor again is a student who struggles with reading and writing, but is a leader in his science group when it comes to explaining and trouble-shooting. His writing is somewhat disjointed in the first paragraph. The second paragraph is much more coherent, and in fact one of the more sophisticated in its description of the electric motor function. However, what is remarkable is that Taylor attempts to produce a neat paper with more than one paragraph (see Figure 3). The majority of his writing as a response to literature rarely even attends to the lines of the paper.

Elizabeth came to the fourth grade with the ability to write… and write, and write and not say much of substance. I had the feeling that she looked at a writing assignment as the filling of a page with neat handwriting. What she writes about electricity goes beyond neatness to communication. Each sentence is informative. Presented as a listing of facts and concepts, it lacks paragraph organization… but the potential is there (see Figure 4).
Carl came to class often with a heavy heart, saddened by separation from his parents. He had acquired the label “angry” and received anger counseling at school. I didn’t see the anger. I did see that he was enormously popular among his friends, who showed most loyalty when he was upset. They would go to great lengths to calm him so that he wouldn’t get into trouble. I also saw that he wanted to learn, but had a very low threshold for learning pain. He would abandon in tears a challenging math problem. If he’d had enough of writing, he’d push papers aside and “go on strike,” and eventually, if I gave him space and didn’t insist on activity, he’d relax and return. When I read Carl’s paragraph, I don’t have the sense that he was feeling tense about the writing task. In fact, he was describing what he did with his buddies and really seems to want the reader to know how to make the circuit work (see Figure 5).

Jake is a student whose papers often suffered wrinkling, crumpling, scratching, doodling and smudging before they were turned in. Often I allowed him my large worktable during class so he could more comfortably spread himself and his work. As for writing form, Jake’s was not exemplary in most assignments. In this assignment Jake directs the reader’s hands through the activity and gives physical and auditory description of the electrical event (see Figure 6).
The value of this writing activity—and of the science activity which preceded it and perhaps made it possible—is evident in each of these samples. These students write what they believe, based on recurrent interaction and feedback with peers and observations in their home environment. Their experience in science class opens a pathway to a motive for writing. Each writer seems inspired to communicate the excitement of what they have observed and learned to a reader.

**Learning Vivid Verbs (and Other Skills): “Today in Science We Got to Make Stuff Bleed!”**

One of the skills expected of my fourth grade students is the use and identification of vivid verbs. This year I introduced the skill in language arts/reading class and experienced defeat. We read, wrote, jumped, juggled and ran, but independent verb choice remained mired in the mundane. I decided it was a skill for which we weren’t ready.

The Open Court writing skills practice prompt states: “Think of an action scene such as a ball game or a walk through a crowded, noisy mall. List several verbs that will bring the action to life. Then write a paragraph using the interesting verbs.” (Open Court, p 52.). Most of the “action scenes” contained routine verb selection: We went to get ice cream,” “I got the ball.”

A week later I introduced chromatography using Crayola watercolor markers and coffee filter paper. I asked my students to write down in their journals what they saw as the pigments wicked up the paper. Their descriptions dramatically revealed the verb use I’d pleaded for earlier:

Lina: The water climbed up the paper and got to the ink and bled and spread and it reprinted in a lighter color at the bottom of the paper.

Ryan: The letters changed and disappeared.

Sean: I see the word. Help is not touching but it is smearing.

Roy: I see that the word is dissolving but I can still see the word.

Jonathan: I see a blurred word it unprinted to the bottom.

Joshua: It’s melting word: The ink is falling off the paper.

Brittany: I seen help it was really bleary words. I also see the word printed down lower.

Carlos: It is bliding (bleeding) wan the wrd is not tuthing (touching) the worter.

Elizabeth: I see the purple dripping…The water soaked into the coffee thing.

Robert: Why the color climed up. The word to disappear. I was amazed at what happed.

Jesus: I expected that the paper would sog and rip apart…The water os carrying The ink up the paper.

Marlon: I see the word dripping.

Trenton: I see that the word desoperd.

Cori: The strips of coffee filter that we wrote on the writring (writing) just slid Down the strip of coffe filter and it was amazing!!!!!!

Alicia: When Mr. Brewer put the coffee filter in the water with “help” on it it Started bleeding. It is now just a few lines/blur of purple. Now it has reprinted in a lighter color.

Maria: Today in science we got to make stuff bleed

Mick: The word blurred. The help reprinted and moved and sanked down. Brown Turned to black.
Arturo: I see the paper with the word help in marker hanging from the rubber Band. “Help” is starting to slide down from where it used to be.

Neil: The help sign started smearing and it moved.

Ah! Pigment is to chromatography as vivid verbs are to writing!

After reading my students’ observations I decided to bring the vivid verb issue back to class and had the students use their science journals as a direct rich language source. I admit I had difficulty containing my enthusiasm!

We spent some minutes gathering verbs on the board—then returned to the same Open Court materials for independent practice. Students approached the task with a science class reference. They accepted as willingly the notion that verbs vary in specificity as they did the idea that water can climb. It seems that when my students perceived themselves as the sources of language expression they found a direct link to examples presented in the Open Court Anthology and worksheets.

The verb experience stands now as a model for future language lessons. Need help teaching the concept of adjectives and descriptive phrases? Have the students observe the physical properties of rocks, minerals, ping-pong balls or ice cream. Having difficulty conveying the importance of prepositions showing place and location? With food coloring, water, oil, soap and plastic cups, it’s a snap! Throw in conflict resolution to boot.

Metaphor we learned thanks to the Wild about Wetlands Kit we borrowed from the Yolo Bypass Wetlands Foundation. The kit included hands-on activities in which students could flood the Sacramento Valley, add toxins to the runoff and filter them and speculate on the specific tasks of various bird beaks, bills, and feet. Reading and discussion tasks included a food web activity, an archaeological activity, and a wetland metaphors activity, which was the most challenging. In the materials provided, wetlands were described as being a sponge, a filter, a cradle, soap, and cereal. It is difficult for fourth graders to use or identify metaphors, but they are expected to do both. Using water, clay, plastic beads and shag carpet remnants in class to demonstrate the properties of wetlands, students began to get some sense of the meaning of the metaphors. After visiting the wetlands where we did soil tests, identified plants and animals, and ate a wetland-produced lunch, their understanding of wetland metaphors was even greater. Later, in their writing, they proudly displayed their knowledge of the wetlands using these metaphors as support elements in their paragraphs. Now when the concept of metaphor arises in reading and language arts classes, the wetland metaphor experience exists as a reference.

We learned Surprise and Suspense, writing elements emphasized in our Open court curriculum, through making cheese! The first (unsuccessful) approach my student teacher and I decided to try involved presenting a hypothetical situation, opening day of your leaf-raking business, a prompt which mirrored a story just read about a child who started an aluminum recycling business. This approach proved frustrating for my student teacher as the students kept at her with questions about what she wanted: Where is this? Who am I in the story? How long does it have to be? It proved so frustrating for students that for the only time in her brilliant internship, my student teacher had to look for me to regain “control” of the rowdy class. The writing produced was insipid and uninspired.

Soon, thereafter, students—totally spellbound—watched a demonstration of cheese-making in class as an extension of a lesson on emulsions. Students observed: “The milk smells good,” “The vinegar smells nasty.” When the student teacher held the vinegar over the milk and asked, “Do you want to know what’s going to happen when I pour this into that,” a desperate chorus of “yes!” rained down.

“Write about that in your journals,” she cried, “this is suspense!” The scribbling that followed was intense. Then, a mixture of gasps and “eewws” erupted as she poured the vinegar into the milk to produce the cheese curd and whey.
“Did you know that would happen?” asked the student teacher.
“No!” came the reply.
“That’s surprise,” she announced. “Write about it in your science journals.” Once again the science activity exists as a reference for understanding an important writing element.

The majority of my students demonstrate much more care about what they read and write when they gain partnership in establishing the language standard to be attained. Science class appears to be the setting where they feel most invited to this partnership.

When I use scripted instructions and the children use workbooks, the challenge is attendance. The skill pages are useful for practice and learning, but they can take on the aspect of “something the teacher wants us to do.” More than once, while students squirmed uncomfortably, I’ve found myself pleading, “Can’t you see? It’s about verbs! They’re really important! It’s right at the top of Reading and Writing Skills Practice Book page 77! They’re verbs! They’re alive!” With science, there’s no squirming. The importance of what we’re doing is manifest—I don’t have to plead. The students are rapt. The realness of the science experience helps concepts take root, and when the student feels ownership of the concept, the skill page seems more a convenience than a hassle.

Katie was Right!

My research experience over the past two years has reinvigorated my resolve to teach science in the elementary classroom and my belief that the teaching of science can inform the teaching of all other subjects. Math is a welcome guest to all opportunities for data gathering. History is more palatable for the nine year old when familiar technology presents, solves and creates conflict. Certainly the same applies to literature and language. Writing in science captures the freshness of discovery Katie saw in class activities. Analysis comes more naturally when one experiments with materials of fascinating properties. Most importantly, science provides a gentle haven for the unexpected.

Children do learn skills in a scripted format. The carefully controlled system currently used to develop literacy gives positive results. However, children can learn much more, and wield literacy skills more forcefully, if they are given a chance to wonder. Science class gives them that chance.

Work Cited:


Samuel Brewer has been teaching for fifteen years. He enjoys taking long hikes to quiet places with his wife and two children. When he’s not teaching or hiking, he tends modest vegetable beds at home.
Revising for Organization and Form

1. Working for a Clear Progression of Ideas

- clarify existing order
  - put brackets around existing parts
  - give each part a title
  - list titles
  - study for patterns
- begin conceiving of better order
  - look for overlap and combine like sections
  - examine relationship between parts and decide on new order (Chronological is often effective as it shows Cause/Effect)
- signpost the new order
  - use subtitles
  - forge focus-sentences
    - topic sentences on main ideas
    - transitions between ideas
    - summaries of sections as needed
- own the narrative/reflective frame—the intellectual tour-guide
  - see mistakes as opportunities for insight
  - articulate significance, boldly assert

2. Considering Proportion

- Consider: which ideas are the “stars” and need to be center stage, which are the supporting cast, which are imposters and shouldn’t even be on stage at all?
- Delete or condense what’s irrelevant: “deletion is the better part of valor”
  - can cut and paste deletions to section at end entitled “Pieces I probably won’t use” until you’re certain you won’t need them
- Expand, elaborate on, or provide examples of what’s most relevant

3. Fine-Tuning the Organization within Each Section

- Examine each paragraph as a whole—look at order of sentences etc.
- Double-check links between paragraphs.

CONTRIBUTED BY JANET PAPALE
Looking for Shape: Some Prompts

Following are some prompts to engage your thinking and writing processes. Read through them and put a star by those that you feel you could easily write to. Put a bullet by those you feel are important questions for you but would be more difficult to write to at this time.

• About your research:
  What are five things I know?
  What are five things I need to learn about?
  How can I find out what I need to know?

• Write a letter to someone in another teacher research group about what you are doing and learning, complete with questions that your colleague could answer.

• Write about your data.

• Describe in detail your research setting.

• Write about a recent telling conversation with a student or someone else.

• Select three different journal entries and write about how they connect or what pattern they reveal.

• If my teacher research were to be read by three different audiences, who would I like them to be and why?

The following prompts are adapted from the AROW Network:

• What are all the words and phrases you associate with the word Research?

• At the end of the day (like today)
  What has been your most important insight today?
  What is perplexing or concerning you after today?
  What is something you want to talk about in the future?

• Pick a topic in education that interests you. Write three questions you have about the topic.

• Write out your research question(s). What makes a good teacher research question? What could you do to make your question(s) better? Rewrite your question(s).

• Write a description of your school and classroom.

• What data collecting ideas do you have?

• What feedback do I have from others which will influence my thinking about my research?

• Complete the following:
  When I think about my teacher research I...
  If I had unlimited time, I would...
  The thing that worries me the most about teacher research is...
  What I’d really like someone to help me with is...

• Fill out an action plan for your research for November/December.

• What data do I currently have about my topic/question?

• What data collection strategies could I use?

• What evidence do I have that convinces me that something is working? Where are the gaps? What do I want to record to be sure that I don’t forget?

• How can I tell my story? What parts do I leave out? What form should it take? Who are the others who might/should/could see what I have written?
We sat together one evening in December, a group of teacher researchers who had been conducting case studies in our classrooms. As we laughed and ate and prepared to share our final drafts with each other, we decided to reflect on what the process of writing up our research had been like. What emerged in our ten-minute free-writes was a pattern of discovery; what had helped most of us make sense of our data was the actual writing itself.

We shouldn’t have found this remarkable. As Donald Murray (1982) writes:

> Your world is the universe you describe by using your own eyes, listening to your own voice—finding your own style. We write to explore the constellations and galaxies which lie unseen within us waiting to be mapped with our own words (p. 7).

During this process, some found surprises in the data, like Jean, who wrote: “What I thought had been the focus of my study became just one piece after I began writing.” Or Ann, who discovered, “As I was writing, I was surprised to hear myself writing that giving my students time to speak in class led to better writing.”

Margie reflected on how writing led her to see what held her findings together: “It wasn’t until I laid out data, wrote and rewrote, that I could see a pattern—the real significance of the notes I had.”

We decided that setting a deadline, having a date to bring our “final” (for now) published pieces to our group to share had helped us analyze and bring together the piles of data we had collected in new and unforeseen ways. Besides providing a way to share what we knew with other teachers, writing our case studies had helped us discover what we knew. Writing up our research is an important tool for us as researchers, guiding us to insights that would have eluded us.

The words of poet Diane Glancy can encourage teacher researchers to turn to their data with a new vision. In her published journal Claiming Breath, she writes: “In writing, life sinks/rises like the moon with new visibility. Another dimension. Seeing what is not seen in a different way than if we’d seen it” (1992, P. 54).

Getting to those other worlds with our words is the challenge of writing up teacher research. In this first “Extensions” column of the journal, I’ll show how some teachers I’ve worked with found avenues into the writing of their case studies. Perhaps their insights can help you and the teacher researchers you work with bring your work onto the page.

I encourage you to try these extensions out, add to the list and let the editors at the journal and other researchers know what you’re finding works for you.

Extensions

1. Use writing to help you brainstorm what you know—and what you still need to find out. After several weeks of collecting data on one student’s learning, Monique Bissett found it helpful to give herself the goal of listing five things she knew about her case study, and five things she needed to find out. She set up a page of her teaching journal like this:

<table>
<thead>
<tr>
<th>5 Things I Know</th>
<th>5 Things I Need to Find Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>About Jean</td>
<td></td>
</tr>
</tbody>
</table>

When other teachers in her support group tried this strategy, they found it helped to point out themes that were emerging, as well as holes in their data.
2. **Make the time to write for ten minutes on what you are noticing, keeping these anecdotal notes for later reflection.** In reflecting on what helped her to conduct her case study, Tiffany Poulin found, “The best thing I did was to take anecdotal notes early. Reviewing the narratives I had written at the end of one month helped me to remember in greater detail. In a sense, reviewing what I had written helped me to see what I had really been seeing.” Lila Moffitt agrees, and finds that setting time for herself at the end of a school day works best: “Having a computer and taking a few minutes each evening to ‘revisit’ Max in my mind gave me huge amounts of data with which to understand his literacy journey. I couldn’t write in class. I needed time and quiet to discover the meaning of his contribution to my day.”

Some teachers, like Laura St John, find that in order to find that writing time, they need to set aside a few minutes within their teaching day. “What works in conducting my case study,” Laura writes, “is to specifically set ten minutes per day for writing. I remove myself from circulating and ‘privately’ do my work.”

I suggest that you find a way that works for you, to write those brief anecdotal notes and reflections that can help to uncover what you are seeing in your classroom.

3. **Write brief memos or narratives about the themes that you see emerging.** “One surprising discovery I made in writing up my case study is that I associated the term ‘risk-taker’ with Max,” writes Lila Moffitt. “I decided to center my write-up around that one literacy theme. Max was living it daily, expressing it in everything he did and said in the classroom.”

Memos might be two or three pages long, or as brief as a paragraph, like this memo Rick Osborn wrote that helped him bring together multiple data points to confirm a finding:

> I was surprised at how well my initial interview with my case study prepared me for examining her writing. After talking to Stephanie about some of the basic or elemental things that she does in her writing, I am able to see the same patterns in her writing itself. For example, Stephanie talked about how she would always write some quick notes down before she stopped writing so that she could remember where she had left off and what her thought pattern was. In her paper, I can see right where she has done this. Then, when I interviewed her again, I was able to confirm this. Stephanie has really opened up to me and allowed me to see quite a bit of what she is thinking.

4. **Write a letter to a teaching friend about what you are learning.** This can help to put together what you are learning in new ways as you explain it to a new audience. Gina Brandt, a high school science teacher, complained that she was “stuck” when she tried to write up all that she knew about Mariah. To help herself get over this hump, she thought about a teaching friend who would be genuinely interested in the issues she was grappling with in working to understand the way Mariah learns and wrote that friend a letter. In her letter, she was able to write in her own voice about her concerns, delights, surprises, and wonder on paper about how she can best meet her student’s needs. When she finished the letter, she had a working first draft, as well as a letter to a friend.

5. **With your support group, experiment with writing different kinds of leads.** The ways that you find work to start your paper will help give you a frame and can also help establish the tone for your paper. At one of our meetings, we brought in examples of anecdotal leads, “telling quotes,” and setting up contrasts—the kinds of leads that Nancy Atwell discusses in *In the Middle* (1987). In the ten-minute free-write that followed, social studies teacher Tom Ustach wrote the following anecdotal lead:

> I entered the rectangular room, sat at the rectangular table, and was introduced. The walls around me were as stale and white as the experts seated at the table. The psychologist opened up the meeting by announcing, “Let’s get this LDT going. Jim qualified LID, SP, handicapped in ’83, ’86, and ’89. How’d he do last week, Academic Specialist?”

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See Lila Moffitt’s article, *Literacy and Risk: The Story of Max* in this issue.
“His current WISC-III is verbal-73. Performance-98, and FSIQ-83. His academic results were Reading-7.6/93, Math-5.4/81 and Written-3.2/68. I've never seen a high school student score so low. He has problems calculating simple addition and subtraction. He can't do basic counting.”

“Speech Pathologist,” the psychologist called.

“Well, I'm embarrassed to say,” answered an elderly woman, wearing milk-yellow 1970’s mineral rock jewelry, “I inaccurately calculated his score. I used the wrong birth date. I can go up and re-do it real quick. Right now I got 74.”

“No, that's OK. If it's 74, then the new one will be even lower,” said the psychologist. “Go on.”

“Well, his CELF-R was really low, too. I'll get it to you as well.”

“Where's his ERC case manager?” asked the psychologist.

“Not here.”

“We'll get to him later, then, but I'll pass the B-5 around.”

Yes, these educational specialists are talking about my case study, who is not a lab rat or an astronaut, but a 15-year old young man who is struggling with writing. He's really not just struggling with writing, but with surviving in a school system that structurally sets him up to fail. A working class student—especially if she or he is a minority student—is rolling loaded dice each time they come to class in today’s public schools. My case study, Jim, has never hit a number in his ten years of public schooling, and all the blame is placed on him.

When Tom shared his lead with our group, it was clear that he had found the way to frame his paper, drawing us all in to his case study, which he went on to entitle “Playing the Numbers: Winning and Losing In Public High School.”

I suggest collecting a range of examples of a variety of leads and experimenting with them. Ralph Fletcher's What a Writer Needs has many different lead-writing suggestions and examples, such as the dramatic lead, the misleading lead, the leisurely lead, or beginning at the ending (Fletcher. 1993).

As Fletcher writes, “[T]he lead is more than the first step toward getting somewhere; the lead is an integral part of the somewhere itself. The lead gives the author his first real chance to grapple with the subject at hand... The author writes for herself and she writes for her audience” (p. 82).

Taking just 10 or 15 minutes to try a new lead and share it with your group or with a research partner can lead to new ways to frame your thinking, as it did for Tom. It's also a small enough task to put on a support group agenda and still have time for lots of feedback, that can help keep your writing going.

6. Set a deadline for a finished draft. Perhaps this is the most important suggestion of all. Setting those deadlines forces us to use the writing, to put our thoughts on paper for an audience. It gives us that all-important opportunity to think through our data, make choices, and find a focus.

These suggestions are just a starting point. I hope you revise and extend them as you work with others. And feel free to send the results of your work to us. The journal editors are eager to read accounts of the process of working with others to write up research, as well as to publish these accounts so others can learn from your labors.

References

In 2002 the first cohort of a group of 75 students earning their teaching credentials from the UC Davis School of Education also committed to continue their graduate work into their first year teaching assignments as part of a Masters of Arts degree program. The central feature of the MA work for these new teachers is Teacher Research. With support of Teacher Education, Pam Castori and Kathy Dixon were invited to be instructors for this program and developed the following "Essential Components" for the MA students' teacher research papers. These essential components may prove useful to facilitators and practicing teacher researchers in our network.

**Essential Components MA Teacher Research Report**  
UC Davis School of Education  
Education 206 C Fall/Winter 2003-04

**Title of your investigation or inquiry/study:**
The following are standard, rhetorical considerations for titles:

 ✓ Is the title descriptive and concise?  
   If the title is long, does its length contribute to some rhetorical effect (e.g., a title could be long because the length expresses exasperation that many teachers share about the topic of the title)?

 ✓ Does the title invite readers into your work?

 ✓ Does the title accurately represent your study?

 ✓ How does a title's punctuation or syntax contribute to its effectiveness?

**Some Examples for Consideration:**
"You Can't Make a Light Bulb Glow in Spelling': In Defense of Fitting Science into the New Fourth Grade Curriculum" by Sam Brewer, *Windows on Our Classroom, Volume 9*

"Measuring Change in Understanding—My Students and My Own" by Rich Hedman, *Windows on Our Classroom, Volume 9*

"Becoming Members of the Math Club: First Graders as Emergent Thinkers" by Betsy Sanford, *Teacher-Researchers at Work*

"The Gong Show: Some Things I Learned about the Evaluation of Writing" by Tony Tendero, *Teacher-Researchers at Work*

"Where Have All the Boys Gone? An Investigation of the Current Lack of Boys in Academically Challenging Courses" by Suzanne Galloway, *Windows on Our Classroom, Volume 8*

"Dump Your Brains on this Paper: A High School Math Journal Investigation" by FaraLee Wright, *Windows on Our Classroom, Volume 8*

"Humor, Shared Responsibility, and Community: Developing a Cohesive Teacher Research Group" by Troy Burke, *Windows on Our Classroom, Volume 8*

**Resources:**
Some published teacher research articles offer examples of effective titles. Examine titles that catch your attention or that seem particularly appropriate for the topic and audience. Notice especially how writers use punctuation in a title. A title with two parts may have the parts linked by a dash or a colon. A title may have a question embedded in it followed by a partial answer to the question. A title may also have a quotation embedded in it.
Context for your study (setting and background):

Describe in detail those features related to the setting and background that are pertinent to your study:

✓ What kind of community does your school serve?
✓ What are defining characteristics of your school (history, demographics, staff, leadership, etc.)?
✓ Who are your students?
✓ Who are you? What background and experience do you bring to this study?
✓ What is your classroom setting like (physical arrangements, etc.)?
✓ What do you teach? How do you teach it?

Some Examples for Consideration:

“Measuring Change in Understanding—My Students' and My Own,” by Rich Hedman, Windows 9, pp. 34-35.


Resources:

Student demographics and other data about a school can be obtained from a link in the California Department of Education’s web page to Dataquest at this URL: http://data1.cde.ca.gov/dataquest/. If you can highlight the subject drop menu, you’ll see that you can select "select your own data." Then select the level you want (school, district, county) and follow the menu prompts. If you’re conducting your teacher research in a classroom out-of-state, research the web site of the state’s Department of Education for links to demographic data and information about the school.

Prepare for writing about the relevant context and background for your study—your school, classroom, and students—with well-selected details by taking notes and journaling. For tips about writing a research log (or journaling or taking notes), see the following:


Note that a well-kept journal becomes a critical source for data.

Research Issue and Need for your study:

✓ What are you interested in finding out about and why?
✓ What data/evidence do you have to indicate a need for your study?
✓ What assumptions/biases/hypotheses do you have that are informing or motivating the focus for your study?
✓ Are there theoretical underpinnings to your research? If so, describe, drawing on relevant articles.

Some Examples for Consideration:


“Student Ownership of Process and Standards: Improving Students' Writing,” by Deborah Stierli, Windows 8, pp. 34-36, paragraphs 1-5.


Resources:


**Data Sources—Description, organization, and methods of analysis**

✔ What data sources are you using (be specific in describing them)? Where, when and how did you collect the data?

✔ What information does each data source offer that relates to your research question?

✔ How did you organize the data?

✔ How did you analyze the data? (What processes did you use to determine what the data meant in light of the research question?)

✔ Note: For WARP #2, you will need to provide at least 3 distinct types of data and at least 2 samples from each type.

**Some Examples for Consideration:**

“This Is Still Physics…Right?” by Kimberly S. McGreevey, Windows 8, pp. 3-8, “What Happened” and ”After It Was Over—Assessing through Essays and Interviews.”


**Resources:**
Remember that a well-kept journal or teacher-research log can be a critical source of data (see resources listed for Context).


**Research Question or Issue**

✔ What is (are) your research question(s)?

✔ Is your question researchable (i.e., can you bring understanding or answers to the issue or question you are interested in investigating given where you are or what you can do?)?

✔ Can you frame your question in different ways?

**Some Examples for Consideration:**


“Between Years: A New Resolve and a Research Focus.”

“To Read or Not to Read (Silently),” by Nancy Salm, Windows 9, pp. 99-100, “Toward a Question.”


**Resources:**
See pages titled ”Framing Research Questions” posted from the CRESS Teacher Research Facilitators’ Handbook (pp. 56-57) on the 206C class website.

See also the resources listed for Research Issue and Need for your study.
Design of Study/Methods of Investigation

✓ Describe your research plan.
✓ Generate a graphic to depict your plan (chart, table, etc.).
✓ What steps/activities are key to your investigation? (E.g., did you design and implement an intervention to address a need or issue?)
✓ How does your investigation map out over time? (Create a timeline or calendar for your research?)

Some Examples for Consideration:

Resources:

Published Resources/Literature References
Use at least four published sources in your report. One source must come from each of the following three categories below:
✓ “traditional” educational research references
✓ teacher research studies
✓ publications by practitioners that are about inquiry-based approaches to teaching or classroom-based research

Some Examples for Consideration:

Resources:
Teacher-Researchers at Work, “Reading,” pp. 77-82.

Results and Findings
✓ What did you find out from the data?
  Represent your results using a graphic (table, chart, diagram, etc.).

Some Examples for Consideration:
“To Read or Not to Read (Silently),” by Nancy Salm, Windows 9, pp. 102-104.

Resources:
Methods for citing your data and representing your results are covered in the pages you read for Data Sources—Description, organization and analysis.
Discussion of Implications and Conclusions

√ Summarize what you have discovered.
√ Revisit your research question and discuss what new knowledge/insights you now have about it.
√ Why are your new insights or knowledge important? (So what? Given what you’ve learned, what are the implications for teaching?)
√ Could this work have implications for you in the future?
√ Are there new or continuing questions you have?
√ What are your next steps for your teaching and/or inquiry?

Some Examples for Consideration:
“A Sometimes Bumpy Road: Developing a Class Called ‘Reading in Science,’” by Laura Bauer, Windows 9, “Next Time.”
“Roll ’em! Video Presentations to Die For!” by Jess Gammon, Windows 8, p. 32, “Conclusions.”
“Revamping Report Cards,” by Mimi Townsend, Windows 8, p. 68, “Where We Go from Here.”

Resources:
Living the Questions, “Identity: Balancing Round Stones,” pp. 241-249. See especially the parallel lists on pp. 248-49. Construct your own list of parallel patterns to help structure your thinking. For example:
I had been concerned with... Now I’m concerned with...
My question(s) had been... Now my questions are...
I had wondered... Now I wonder...
I used to... Now I...

Abstract

In 250 words or less write a summary/overview of your study.

Some Examples for Consideration:

Resources:
Bibliography


Patterson, Leslie, Carol Minnick-Santa, Kathy Short, and Karen Smith eds. 1993. "Teachers are Researchers: Reflection and Action." International Reading Association, Newark, NJ


Web Connections
REEd, UC Davis — education.ucdavis.edu/resources-excellence-education-reed
AERA Teacher as Researcher Special Interest Group (SIG) — www.aera.net/AboutAERA/MemberConstituents/SIGs
National Writing Project — www.writingproject.org/
Center for Improvement of Early Reading Achievement — www.ciera.org/
ERIC: Educational Resources Information Center — eric.ed.gov/