Energy Conversion:
The Evolution of Experimenters’ Workshop

by

ALEXA STUART

One day, in the last year of my training to become a teacher, Dick Rezba, my instructor in a science methods class, set a bag in front of each student. The bags contained a collection of objects which inspired no particular excitement: wires, coils, batteries and magnets.

Dick said, “I want you to experiment with these for about 30 minutes, and then we will share what we discovered.”

I opened my bag hesitantly, almost frightened to touch anything. I had rarely touched things in science class, except on command. “Hands-on-science” in my education usually meant watching demonstrations and conducting experiments to the rhythmic mantra, “O.K., don’t touch until I tell you. Otherwise, it might not turn out right.”

Now I was invited to touch without restriction. In the classroom, the excitement was palpable.

“Wow, look at this!”

“Does yours do that when you put the magnet close?”

“Let me see if it does that again.”

“What did you do to make yours do that?”

“I wonder why it does this?”

“I wonder if it is because the magnet affects the electron’s flow?”

“Let’s see, if the current is flowing because of the magnet, then this should happen when I try this.”

At the end of 30 minutes, we had a lively discussion about what we had observed and why we thought it had happened. I realized that in 16 years of science education, this was the first time I had been allowed to truly experiment.

Dick went on to encourage us to create experiments based on our interests. I liked to make chocolate chip cookies, so he encouraged me to brainstorm cookie experiments. For example, I compared the taste of cookies made with margarine to those made with butter.

I came to realize that, outside of science class, I had been doing the work of a scientist over much of my life. Years earlier, for instance, when my brother and I had raced home from the neighborhood store, each using a route we believed was shorter, we were conducting experiments. Our argument about whether one of us was running faster than the other was an argument about controlling variables. When our
mother tried to help us settle the dispute by driving
the two routes, odometer running, we were — be-
cause no automobile can cut corners like a kid in full
flight — left with a dose of the uncertainty that drives
scientific work.

The unspoken reality was that
students were often writing for me
and not their classmates — and it
showed. The writing lacked depth
and enthusiasm. And to be honest,
I didn’t look forward to reading
thirty explanations of how
photosynthesis works.

I had also been conducting experiments during my
student teaching when I tried a new approach to quiet
a noisy class, reflected on the results, and used this
information to inform my next approach.

I was excited by my new understanding of the pur-
pose of science and experimenting. Experiments
moved from the pages of the science fair books to
become a part of day-to-day reality. However when I
began teaching, the demands of the curriculum, the
pressures of the job and my own insecurities about
trying something new made it difficult for me to
change my science program from the way I had been
taught in elementary school.

As a new teacher, I became involved with the
Writing Project and was exposed to the concept of
writers’ workshop. It made so much sense to me.
Of course, students learn to write by actually writ-
ing instead of by filling out worksheets. In writers’
workshop, I had children craft pieces according to
their own interests and experiences, hire editors,
and publish their work as they became “featured
authors.” Students begged for more writing time.
They dedicated themselves to the task of produc-
ing quality work they could share with others.
They constantly surprised me and themselves with
fresh insights.

Science class, however, had no such flow to it. Even
though I prepared for hours trying to make the cur-
riculum goals clear — for example, teaching the rela-
tionship between mass, weight, density and volume
— my science teaching left me feeling strangely empty.
I often used writing to test the students’ understand-
ing of a science concept, but the unspoken reality was
that students were often writing for me and not their
classmates — and it showed. The writing lacked depth
and enthusiasm. And to be honest, I didn’t look for-
toward to reading thirty explanations of how photosyn-
thesis works.

My other goal was to use hands-on experiments, so I
led the class through experiments I found in books. It
was a constant struggle to keep the children following
the prescribed steps. When I had the class respond to
questions about experiments, again their writing was
rote and predictable.

I worked hard to prepare demonstrations, spending
time prepping and getting everything just right. Then
came the “wow,” and then it was over with lots of
clean-up ahead.

I became particularly aware that my science class
lacked purpose when I contrasted it with the excite-
ment and energy of the writers’ workshop. When I
had children write their thoughts about writing, they
wrote:

Writing is a wondrous thing. Whatever you’re think-
ing ends up on you’re paper before you even finish
thinking about it.

Writers’ workshop is like blossoming into a new
flower.

When I had them write about science they wrote:

Science is like a pencil. It begins and soon it’s gone.

Science is like learning about one topic after another
in a lot of detail.

Science is like ... I couldn’t think of anything.

This writing exercise affirmed what I had noticed.
How could I explain the difference between students’
clear and joyful statements about writing and their
foggy, uninspired statements about science? What
was I going to do about it? After a great many false
starts and days when I put in more time hoping that
things would feel different, I thought back to my experience in college. Maybe I could create a science workshop much like my writers’ workshop. Just as students in writers’ workshop became engaged as writers, students in experimenters’ workshop could become engaged as scientists: constructing hypotheses, experimenting, and sharing findings. I would start with a mini-lesson and then, just as students in writers’ workshop designed their own pieces, students in science workshop would design their own experiments. In both, students would write, share, respond to each other and publish their finished work.

The children were completely absorbed in their work. Suddenly, they cared if their measurements were accurate, and they put me to work showing them how to recalibrate a scale.

I decided to give it a try. Since we had been discussing states of matter, I gave each child a cotton ball dipped in rubbing alcohol, a cotton ball dipped in water, and threw in a piece of recycled paper for good measure. I explained the basic structure for what we would be calling “experimenters’ workshop.” I made clear that the process would be similar to writers’ workshop. I told students they could use any tools on the science shelves, such as scales and thermometers, and that they should write down their observations and explanations so that we could share them. My biggest fear was that when I said, “now experiment,” they would not know what to do.

I was surprised that my brief guidelines were not followed by a barrage of questions. The students seemed to know exactly what to do.

Of course, a part of me was hoping that within the context of their new-found freedom students would still do what I wanted them to do. That is, since we were studying states of matter, they would compare the evaporation rates of alcohol and water. Some students did. One student was glancing back and forth between the clock and the streaks of rubbing alcohol and water she had made on her recycled paper. When the alcohol streak disappeared, she recorded the time in her learning log, and then recorded the time when her water streak disappeared. She subtracted, calculating the difference. One student dropped her two cotton balls from above her head to the recycled paper on the floor to see if one dropped faster than the other. Most students went in directions that would not have occurred to me. One child was weighing each cotton ball to see if one weighed more than the other.

The children were completely absorbed in their work. Suddenly, they cared if their measurements were accurate, and they put me to work showing them how to recalibrate a scale.

They were talking like scientists. I heard conversations like this one:

“Wow, look at the different color the alcohol makes on the paper compared to the water.”

“Does yours do that too?”

“I wonder if the same thing happens on a different color paper? I think I’ll try it.”

I was no longer on center stage. Rather, I moved about the room prodding students with questions they were probably already asking themselves: “Why do you think that happened?” “How can you test that theory?”

For the first time in my science class, everyone wanted to share, to be the featured scientist. We ran out of time to share findings, and children were disappointed. But I was very excited and wrote in my journal that night all about experimenters’ workshop and how I could improve it.

As I modified the structure for experimenters’ workshop, I kept in mind the elements that made writers’ workshop run smoothly. In writers’ workshop, I started with mini-lessons that introduced students to everything from story starters to the conventions of capitalization. For experimenters’ workshop we had science mini-lessons: lessons on content provided in our science curriculum (i.e. how photosynthesis works); lessons on how to better use scientist’s tools, like scales and thermometers; lessons sharing exciting stories behind discoveries; lessons about current puzzles in science, such as how life began.
Next came experimenting time and writing time. I provided materials based on the content area we were studying. For example, when we studied heat energy, I supplied ice. When we studied plants, I brought seeds, flowers and leaves. I tried to find cheap items and encouraged students to use creative materials: heat from their bodies during our study of heat, leaves they themselves had collected as we studied plants. The class was told to use the materials to learn about the subject we were studying, but the rest was up to them. Sometimes I would pose a specific problem for the whole class. I'd ask, for instance, "Which is denser, vinegar or water?" and let them create different experiments to find out.

When children wanted to meet with me, they signed up on the chalkboard. They usually wanted to show me something. If I saw something creative, I'd say, "You really ought to publish that. The class will love it." In order to publish their findings, the students must write about what they did, what happened, and why they think it happened. I also wanted students to assess the chances that their speculation was, in fact, correct.

They were then expected to hire a content editor to comment on their work, and if they wanted to present as a featured scientist — a role similar to the featured author in writers’ workshop — they were required to hand in a checklist certifying they had completed all the necessary steps.

Featured scientists received feedback on their work, both strengths and suggestions. Recently, one featured scientist, Jessica, presented her experiment to discover whether vinegar or oil was denser. As the room settled, she began reading her paper while standing behind a desk on which were placed bags of oil and vinegar and a scale.

---

**Two Workshops Compared**

<table>
<thead>
<tr>
<th>Writers’ Workshop</th>
<th>Experimenter’s Workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. In order to learn to write, you must actually write.</td>
<td>1. In order to learn to do science, you must be engaged in the core activities of science: constructing hypotheses, conducting experiments, and sharing findings.</td>
</tr>
<tr>
<td>2. Authors need to design their own pieces according to their own interests and experiences.</td>
<td>2. Young scientists need to design their own experiments according to their interests and experiences. Young scientists need to learn that they can create their own categories and have the flexibility of thought to see the world in a new way if it is needed.</td>
</tr>
<tr>
<td>3. The purpose of teaching writing goes beyond preparing certain students to be published authors as adults. All children and adults grow from the joy of sharing their messages through their writing.</td>
<td>3. The purpose of science education is not simply to create career scientists. All children and adults benefit from using the core elements of science as a way of gaining knowledge in all areas of life.</td>
</tr>
<tr>
<td>4. Children need to recognize themselves as authors.</td>
<td>4. Children need to recognize themselves as scientists.</td>
</tr>
<tr>
<td>5. Although the process of writing can be sorted into clear steps, these steps take on individual life with each person and each piece.</td>
<td>5. Although the process of science (the scientific method) can be sorted into clear steps, these steps take on individual life with each person and each spark of curiosity.</td>
</tr>
</tbody>
</table>
Vinegar Is the Key
My experiment shows that vinegar is more dense. I have complete confidence in my experiment because I was as accurate as I could be.

What I Did
To prove that vinegar is more dense I did an experiment. I put some vinegar into a plastic bag. Then I put the exact same amount of oil in another plastic bag the same size. Then I put both bags on the scale in our classroom.

What I Observed
When I put the bags on the scale the side with the vinegar automatically dropped. That shows that vinegar is more dense.

Then Jessica put the bags on the scale, demonstrating what she had just reported.

Hands shot up. As with writers' workshop, students have been encouraged to make positive comments: "I like the way you made up your experiment," one student said, "I think that was a good test."

"It was clear and easy to understand," said another.

Other students had questions. "What if the scale is just wrong?" one asked.

Jessica said, "No, I thought it was at first, so I tried it on two different scales. Look." And she was off to the back of the room to grab another scale to weigh it again for the class.

"Are you sure you put the same amount in each bag?" another student wanted to know.

"Yes, Ms. Stuart was there when I measured it, weren't you?" said Jessica.

When Jessica was finished with her presentation, she put her paper in our published science discoveries binder.

Students love to be featured scientists, so sometimes they write quickly and ignore their editors. For instance, when we were studying heat, I made ice cubes and thermometers available to the class. Two students decided to see if they could find something to melt ice quickly. At the end of class, they published their findings called "Which Ice Cube Will Melt First?"

They read:

We have 3 containers. In one container there is just soap. In another container it is water. In the last container it has water and baking soda. We are going to find out which ice cube melts first.

After a few minutes...

1) baking soda
2) plain water
3) soap

They found that the ice cube with the baking soda melted first, then the ice cube with the water and then the ice cube with the soap. That's all there was to it. The students liked this experiment, but because the write-up had been cursory, the questioning was also cursory. I thought this would be a good experiment to take further, so I photocopied the experiment and the next day asked all students to try the same experiment to see if it turned out the same.

At the end of class, many students were racing to find editors eager to publish their findings which differed from the results of the original experiment.

Two students published a write-up called "Ice":

We did the same experiment, but we did things more correct. First of all we made sure that each ice cube was exactly the same size. Second of all we put the same amount of everything so that there wouldn't be more baking soda etc. We put baking soda in first, then soap, then water. Answer: The ice with the water melted first. The ice with the soap melted second. The ice with the baking soda melted third.

List (to make sure you do it right)

1) You have to have the same size ice cubes.
2) You have to have the same amount of water, soap, and baking soda.
3) You have to have the same size containers.
4) The ice cubes have to be the same temperature.
5) If one container has a top, all the containers have to have a top. If one container doesn't have a top, all the containers have to not have a top.
6) One container can’t be closer to the window than the others.

7) Don’t do anything to one and not all, like mixing.

Not all students had the same results although, surprisingly, water melted the ice first overall. After this presentation, the whole class started to pay more attention to variables, although they didn’t yet use the word. Neither had my brother and I when, at about their age, we were arguing about the “fastest” route to the store and yelling, “Yeah, well maybe you just run faster.” And, like my brother and I, students began to struggle with the uncertainty of what they discovered. They began to realize all the things that can go wrong. Fewer announced, as had Jessica, “I have complete confidence in my experiment because I was as accurate as I could be.” More papers were ending with conclusions like:

Yes we are pretty sure of our theory. But not really sure. We could do many other experiments to be more sure.

I thought back on a comment a student had made when, a couple of years earlier, I had encouraged students to use a certain hands-on science book to try some experiments over the summer: “If you know exactly how the experiment is supposed to turn out, what is the point of doing it?” Now, like working scientists, my students are not sure how their experiments are going to turn out, and they find that process thrilling.

I learned from my experience with writers’ workshop that school writing does not need to be divided into so many little parts that what students do no longer resembles the art of writing. When I applied the concepts of writers’ workshop to science, I found a way to present science so it would not be diced into narrow activities that rob students of the joy of asking, “What will happen if I try this?” and then embarking on a journey of experiment and explanation to find out.

Now when I ask my students to complete the statement “Science is…,” the responses are dramatically different than they were a year ago:

Science is finding a problem and figuring out a way to solve it and then trying to solve it and seeing if it works.

To me it is trying to find out different things. You do experiments every single day. Sometimes you don’t even know it. If you don’t experiment that means you never try new foods, clothes, hair styles and you just don’t try any new things at all.

Science is like jumping higher and higher until you find the things you were looking for.

Science is like being surrounded by many doors. Each door is a different experiment with a different answer. It all depends on which door you pick.

Alexa Stuart is a fourth grade teacher at Sacred Heart School, San Francisco, CA.

Now, like working scientists, my students are not sure how their experiments are going to turn out, and they find that process thrilling.

This year, although we spent less time going over formal content such as density or photosynthesis, their working knowledge of basic content seems far stronger than it did last year. The students use science vocabulary frequently when they write and have numerous occasions to use content to devise theories explaining why things happen. I have a much clearer insight into their understanding of concepts.