"Hello, I'm Carbon.": Writing about Elements and Compounds

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"Hello, I'm carbon." began the paper. The writer was three weeks into his first semester of college and a student in my general chemistry course. The assignment was to assume the identity of an element and write that element's autobiography.

I have used this and similar assignments for a number of years in the spirit of pedagogical approaches such as writing across the curriculum (WAC) and writing in the discipline (WID) *(1)*. Using writing as a teaching tool in chemical education *(2−6)* has a growing history in chemistry *(7, 8)*, even if it remains underused.

Such assignments fulfill several course objectives. Principally, they address the objective that students form a real connection with some aspect of chemistry. They also address other objectives, including enmeshing writing in the course as thinking and learning tools *(4)* and involving students in a process-writing project. This project also sets the stage for later writing assignments in which students are asked to think deeply about more substantive chemical issues. Lastly, when a course has a significant number of students taking it solely to fulfill a general education requirement, this assignment provides a potentially less daunting way for them to begin their study of chemistry than more typical chemistry assignments.

This last point is not insignificant. Nonscience students who take general chemistry only for general education credit are often overwhelmed by the mathematics of the course, which usually appears early on with units and unit conversions. My observations suggest that this story-driven writing assignment gives such students a source of pride and self-confidence, and more importantly, ownership in the class. Others have also observed these ancillary benefits *(5, 9)*.

I have used several versions of this assignment and a variant involving industrially important compounds in courses for both science majors and nonscience majors. Most recently, I used a version of it, more focused on the history of the element's discovery, in a graduate course in the history of chemistry offered within our Master of Science Teaching program.[1]

The assignment asks students to do a bit of research about the discovery, sources, properties, and uses of their element or compound and then weave these into a story from the perspective of that element or compound. Asking them to write well generally causes students to think more deeply about these concepts, in turn allowing them to more successfully weave them into a story. This places this assignment firmly in the "write-to-learn" tradition *(2, 8)*.

Because this assignment occurs early in their college careers, students often need help finding appropriate resources. Consequently, I give my students a list of library and Internet resources they might find helpful. One particularly good reference is *Discovery of the Elements* by Weeks *(10)*, which I put on reserve in the library. I do require a bibliography with the autobiography assignment and currently require that at least two references be from the library.

For years, despite my encouragement to "be creative", or "tell your own story", and my advice to "write a story, not a report", most of the autobiographies were much too report-like. Only rarely did I see a truly creative effort. Several years ago I tried something new that resulted in much more story telling and less report writing. I introduced the assignment by reading excerpts from the chapter on lead in *The Periodic Table*, by Levi *(11)*. In this chapter, a descendant from a family of lead prospectors in the Middle Ages tells a story of searching for a new vein of lead ore. The story relates information about the properties of lead and its ores, early smelting technology, early uses of lead, and lead poisoning. Reading selected parts of this story, which took about 5 min, convinced many of my students to tell their element's story in a creative way rather than to merely write a report.

Other stories could work equally well. I now have a collection of the best (and a few of the worst) of my students' autobiographies and their permission to use them in future classes. Recently, I read a student's excellent and rather short autobiography of gold (see below) together with portions of a rather less creative autobiography. The combination appears to have been successful in both freeing students to be creative and alerting them of the pitfalls of a report-like story.

Examples

The autobiography quoted in the title of this paper ("Hello, I'm carbon.") began well but did not live up to its beginning, devolving into a report about carbon, rather than a story. Its revision was more of a story but still too report-like. This autobiography, written about 10 years ago, was typical of most of the autobiographies in the early years, being too much a report and not enough a story.

Perhaps the best autobiography I have received to date came from "Miss Lead" who alternated between (i) describing her useful properties and products, and (ii) her poisonous nature, using a good-twin, bad-twin format. The flip-flops became increasingly abrupt and the two positions more extreme until near the end of the story where she reveals that she is in a mental hospital being treated for schizophrenia.[2]

Gold wrote of her idyllic life surrounded by many friends (rocks, minerals, and fish) in a mountain stream. This suddenly morphed into the agony of being removed from this environment and swirled in a pan, and the terror of being melted together with others of her kind, cast as an ingot, and finally beaten into gold leaf to gild the frame for a painting. "At least it

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Table 1. Traits of Good and Poor Elemental Autobiographies Used To Evaluate the Assignment

Rubric Dimension	Positive Characteristics	Negative Characteristics
Story Quality	Engaging story of an element	"Report" about an element
	Strong narrative	Disjointed narrative
	Factual information woven into the story line	Factual information detracts from the story line
	Long enough to tell a good story[a]	Too short or too long[b]
Writing Quality	Precise use of language and sentence structure	Sloppy language and/or sentence structure
	Good use of college-level vocabulary	Poor, simplistic or inappropriate word choices
	Good transitions between sections	Weak or missing transitions
Science Content	Significant science woven into the story	Little or no science in the story

[a] Experience suggests that good stories are generally between 1000 and 2000 words. [b] Stories with 500 or fewer words are generally overly simplistic, while stories longer than ~4000 words are usually wordy and padded with unnecessary information.

was a Rembrandt", she says. This outstanding student−writer vividly related the emotions of the story.

Iodine-123 "spoke" rapidly, trying to get a lot of information in very quickly because, "as likely as not I will be gone in 13 h". (The half-life of ^{123}I is 13.27 h.) This story began with well-crafted language but gradually changed to shorter and choppier sentences and finally ended midsentence, concluding with the words "I am Xenon".

The autobiographies of lead, gold, and iodine-123 are particularly impressive, yet I receive similarly strong stories from most of my students if I read excerpts from excellent stories to my class. When my students finally believe that I want a story, and free themselves to write one, they produce quite imaginative results. The key seems to be sharing a good example of what I have in mind.

Assignment Grading and Other Mechanics

When chemists begin discussing the use of writing in their courses, questions about grading often arise *(8)*. Many chemists feel underprepared to teach or grade student writing, and I place myself in this same position. The good news is that we can usually recognize good and bad writing and, with appropriate guidelines, can effectively distinguish different levels of writing skills and story quality. I am still unable to teach my students how to write better, but I do make extensive use of the writing laboratory[3] on our campus to do this for me.

This process-writing assignment typically takes half a semester. Students begin in the second week by selecting their element. An expanded outline with a preliminary bibliography, which is reviewed by the instructor, is due three weeks later. An initial draft is due a week after the outlines are returned. This draft is peer-reviewed.[4] The final story, revised based on the peer reviews, is due at midterm.

This assignment is the most extensive of several writing assignments I use in general chemistry. The other writing assignments deal explicitly with course material, often asking students to think deeply and write about more conceptual material *(4)*. I find that students, having seen that I expect good writing on the autobiography assignment, spend more care with the remaining writing in the course.

The autobiography assignment is worth 15% of the course grade with points distributed throughout the process. When I first began using this assignment, it was worth 8−10% of the entire course grade and a small number of students choose to ignore the assignment. After increasing the assignment to 15% of the course grade,[5] very few students have ignored it.

A grading rubric of the three most critical dimensions of the assignment is used to evaluate the assignment:

1. Being a story versus a report
2. Science content of the story
3. Writing quality of the story

Table 1 provides a list of the traits evaluated by the rubric arranged by the grade axis to which they belong. The traits for each axis are combined in both the descriptive and grading rubrics, then broken down into different performance levels. Complete descriptive and grading rubrics, as well as the written assignment, are available as supporting information.

The writing process includes a peer review using the same grading rubric that I use. I also review the paper. If these reviews identify poor writing mechanics or word choices, the student−author is required to consult the writing laboratory on campus. I am notified when the referred student visits the laboratory and the final draft is not accepted until I have been notified. I find that students who have used the writing laboratory almost universally improve their stories. I am unable to provide my students the same high-quality writing guidance.

Over the years, I have had a few students who refused to do this assignment. The most typical reason was that they did not think it taught them any chemistry, a complaint others have also heard *(12)*. However, every year I use this assignment I find myself able to refer to at least 20 stories for each element covered in class. That I can use those stories to illustrate concepts in class suggests that this assignment really does teach chemistry, just in a different way.

I have used this assignment in general chemistry classes with 20−60 students. With 20−40 students, I find that the time I must spend evaluating portions of the assignments is manageable; with 60 students, it was a burden. I do not feel that this assignment, as I use it, is realistic in truly large classes. It may be feasible if graduate students, and hopefully some in the English Department, could handle the grading.

Feedback

Some years ago I taught at Morningside College, a small, private, liberal arts college, whose English Department ran a program called Wednesday is Writing Day in which students from courses all over campus share their writing over lunch. One year several of my students shared their elemental autobiographies in this program, drawing considerable interest from both English and Education faculty and an invitation to return in future years.

More recently a student taking my general chemistry course solely for general education credit sent me this e-mail message:

> Finally! Something I can do well. I showed this assignment to my English 1050[6] professor. She said that your assignment was better than some of the ones she uses and let me use my autobiography in her course.

The English instructor involved in fact contacted me saying much the same thing and asking more about my assignment.

I have not formally studied the depth and degree of learning this assignment facilitates, but unsolicited free-response comments on course evaluations consistently single out this assignment for praise. Carroll and Seeman *(13)* use an autobiography assignment in an advanced organic chemistry course. Their students read the autobiography of a significant scientist and collaboratively study the seminal papers of that person's career, presenting their findings orally to the class. They report deep and long-lasting learning from this project. I have not collected data relative to long-lasting learning, but evidence suggests that my students do make a substantial connection to chemistry by writing an elemental autobiography. I have noticed that, in semesters where I have used this assignment, or others using a process-writing approach, students tend to write better on subsequent writing assignments.

I find that this assignment serves its intended purposes admirably well at least partially satisfying several of the course objectives. It demonstrates that good communication skills matter, even in chemistry. It sets the idea that writing well is a valuable learning tool. Lastly, it does in fact connect students with chemistry in ways the remainder of the course seldom does. So... Choose your element and write your own story!

Notes

1. I was mildly disappointed with these stories. These graduate students basically wrote about the historical discovery of an element rather than creating their own story. Because the historical story was already there, the fault lies with the assignment rather than the students in this case. I have concluded that students should be left free to develop their own story.
2. This student—author's self-diagnosis of schizophrenia, though the popular understanding of the term, is a misdiagnosis. A more appropriate diagnosis is that Miss Lead suffers from multiple personality disorder.
3. Writing help is available for students on many campuses under a variety of names. If you are not already familiar with a program on your campus, ask someone in the English or Communication department if writing help is available.
4. In different semesters, I have used either a lecture or a lab period for the peer review. Using a lab period requires that I teach both the lecture and laboratory portions of the course.
5. This increase in significance coincided with the addition of peer review, justifying the increase.
6. On our campus, English 1050 is a required writing course that students must take their first year and must pass (in multiple attempts if necessary) before graduating.

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Supporting Information Available

Writing assignment description, including grading rubric and form for peer reviewer to complete. This material is available via the Internet at http://pubs.acs.org.

