ChemWrite:
A Collaborative Model of Writing in the College Chemistry Curriculum

Sandra Prior, Bhawani Venkataram, Robert Battistini, Len Fine
Columbia University

Overview

The pages of *Journal of Chemical Education* attest to the growing interest in integrating writing assignments into college and university chemistry curricula. Recent articles have suggested that students write expanded lab reports, assessments of chemistry journal articles, "microtheme" explanations of difficult course concepts, term papers on contemporary research, reports on the development of a particular chemist's research, and proposals for instrument purchases.[1] In our assignment, students explore the ways their classroom work gives them a deeper understanding of chemical concepts in the book they read. We base our program on students' reading of a science-related book intended for non-specialists, an idea that Lorrie Comfort explores in a recent *JCE* article.[2]

Many of these *JCE* writers report frustration with grading students' written work. In addition, these articles report very little collaboration between science and humanities departments. We have found that this sort of partnership can solve the grading problem, produce a precisely-worded assignment, and enrich the educational experience of students in both the natural sciences and the humanities.

Our Assignment

Too often students imagine that their textbooks report immutable truths of the physical world. One of our objectives is for students to appreciate the human dimensions of science: that research is conducted by groups of people prone to the usual human virtues and vices. We want

students to gain an appreciation for the provisional nature of scientific knowledge and the social nature of its production.

Students first choose a book from a list of six or seven. The lists from fall semester emphasize the historical context of science[3]; spring books have a more literary focus.[4] Students then write an essay of 500-600 words. The first part of the essay is a brief summary of the book; in the second, students focus on a section of the book that applies chemistry they have learned in class. Students must argue that the scientific work in their book would have been impossible without the textbook chemistry they have recently studied . Thus class concepts are applied to a context beyond the textbook and exams.

Writing assignments must be very carefully worded; in a class of six hundred, if a word or phrase can possible be misconstrued, it certainly will be. If an assignment can be done more simply or less thoughtfully, again, it will be. Because the staffpeople from English have more experience in the precise wording that produces the best student writing, the creation of the assignment document is a key moment of collaboration between the two departments.

Students write two drafts of their essay. On the first draft students receive extensive comments but no grade; the second draft is given a grade and brief comments.

Our Graders

Students benefit most when their writing is not merely assessed for a grade. Yet assessment is the objective of the "holistic" grading that some *JCE* writers have discussed[5]. Students also need suggestions for improvement, and an opportunity to practice these skills. But most chemistry faculty have neither the time nor the training to respond in this way to student writing.

We run our program at a research university with graduate departments. Humanities graduate students are skilled in responding to student writing and eager to pick up extra work. We distribute an e-mail advertisement to humanities and writing-arts departments. Applicants submit a curriculum vita and grade a past ChemWrite essay. Students from English, Comparative Literature, and Creative Writing comprised our grading staff. More than half the staff members over the years have been veteran composition teachers, and the rest have had other experiences as editors or teachers.

Our Grading Process

The staff was trained in two intensive sessions. Our goal is not for students to produce a perfect essay; rather, we want students to learn as much as they can about using writing to explain science. Graders learn not to edit or proofread student work. Instead, we train our staff to write questions rather than corrections in the margins and to write an end comment with concrete suggests for improvement.

The first drafts are turned in mid-semester, commented on by our staff, and returned to students. They have two weeks to complete a final draft, which is graded and returned at the final exam. Grades are assigned less on achievement than on improvement. Students who have earnestly attempted to apply their grader's suggestions usually receive a perfect score. Our staff makes fewer comments on the final draft than on the first, but an explanation is still given of the grade. ChemWrite is worth 16% of the course grade.

Schools without graduate programs can still implement a version of ChemWrite: senior humanities majors could be recruited as graders. A more extensive training session might be

required, and because graders and students would be peers, the grading should be blind. Papers could be identified by a student number instead of a name.

Comments on Other Chemistry Writing Programs

Articles in *JCE* have suggested two solutions to the problem of responding to student writing. Without the assistance of humanities readers, it may be necessary to rely on both these techniques. One is 'holistic' grading. A *JCE* writer[6] describes this as 'the reader's instinctive judgment of a piece of writing.' The essay should 'read smoothly' and convey the author's points 'clearly.' But how can students improve on the basis of a reader's 'instinctive judgment'? For assessment of student writing to be useful to the student, a grader must be attentive to the mechanisms of expository writing--that is, the student's logic and rhetoric.

The other proffered solution is to refer students who need help to a "writing center." Though writing centers may be effective for other writing projects, we are skeptical of the effectiveness of writing centers for a program like ours. Instructors tend to have exaggerated notions of what can be accomplished in a writing center. Already accomplished writers benefit the most from one-on-one editing; but for a student writer, more proofreading than learning usually occurs. A writing center tutor would be at a particular disadvantage for a ChemWrite student: the tutor would know nothing of the program or its texts.

In addition, a writing center is a less effective use of university funds than hiring a ChemWrite grading staff. A trained grader can efficiently identify deficiencies in four essays of this length in an hour. A writing center staff person would only see two students in an hour and perhaps be distracted from making the trenchant critiques our solitary graders make.

Possible Critiques of ChemWrite

Two objections could be raised to our program. One, the staff must be paid. Each grader was compensated $1000 for grading two versions of 50-60 essays. For a fall and spring lecture of 300 students, the annual cost of the program would be $10,000-$12,000. Monies for a cross-departmental program such as this might come from a school's college of arts and sciences. We believe that having student writing responded to in a thorough way by nearly-professional writers is a funding bargain.

A second possible concern about our program is the use of non-scientists to grade work by science students. But we have not found this to be a problem. The ChemWrite books are not intended for specialists, and the ChemWrite essay is intended for a similarly non-specialist audience. Students are learning to use writing to articulate their understanding of chemistry for the intelligent layreader--precisely the audience that scientists most need to communicate with.

Response/Assessment

Student response has been favorable to ChemWrite. An education assessment expert surveyed our students the first two semesters that the chemistry and English departments collaborated on ChemWrite. (See appendix.) Only a third of students that year disagreed that ChemWrite helped them learn chemistry. Only a quarter felt that they had not benefited from ChemWrite and that ChemWrite would not provide a future benefit. [7] In the first survey semester, over half the students 'most liked' that ChemWrite introduced them to different perspectives concerning the application of chemistry and science in the real world.

A number of students commented on the ways that ChemWrite affected their notions of how scientists interact and scientific knowledge is produced. They learned that "the scientist's

personality can influence his or her work," that "great discoveries are sometimes accidental and results of trial and error," that "there is a lot of competition among scientists," and that "chemistry isn't always completely serious and sullen."

The grading staff has been similarly enthusiastic. Staff members were able to apply their skills of reading and assessment to subject matter they rarely address. Additionally, readers were impressed by the amount of improvement from one draft to the next.

Appendix: Student Responses

5=strongly agree 4=agree 3=neutral or undecided 2=disagree 1=strongly disagree

Values are reported as percentages.

	SA	A	N	D	SD	Other
Fall 1998: n=493						
"The ChemWrite assignment in this course was effective for learning chemistry"	10	24	25	26	13	2
"Overall, I feel I benefited from the fact that I was involved with ChemWrite"	14	35	23	13	11	3
"I feel that there will be a future benefit to my having participated in ChemWrite"	15	34	10	20	17	3
"One of the things I most liked about ChemWrite was the different perspective concerning the application of chemistry and science in the real world"	18	43	23	8	4	4
"One of the things I most liked about ChemWrite was that it heightened my interest in chemistry"	11	28	34	15	8	4
Spring 1999: n=271						
"The ChemWrite assignment in this course was effective for learning Chemistry"	21	27	27	18	6	1
"Overall, I feel I benefited from the fact that I was involved with ChemWrite"	19	20	29	20	10	2
"I feel that there will be a future benefit to my having participated in ChemWrite"	20	23	35	14	6	3

"One of the things I liked most about ChemWrite was the different perspective concerning the application of chemistry and science in the real world"	6	21	32	26	10	5
"One of the things I most liked about ChemWrite was that it heightened my interest in chemistry"	17	20	35	19	4	5

[1] Rosenthal, L. C. *J. Chem. Educ.* **1987**, 64, 996. Stanislawski, D. A. *J. Chem. Educ.* **1990**, 67, 575. Cooper, M. M. *J. Chem. Educ.* **1993**, 70, 476. Sunderwirth, S. G. *J. Chem. Educ.* **1993**, 70, 474. Wilson, J. W. **1994**, 71, 1019. Rossi, Francis M. *J. Chem. Educ.* **1997**, 74, 395. Hunter, A. D. *J. Chem. Educ.* **1998**, 75, 1424. Wallner A. S.; Latosi-Sawin, E. *J. Chem. Educ.* **1999**, 76, 1404. Kovac, J.; Sherwood, D. W. *J. Chem. Educ.* **1999**, 76, 1399. Shibley, I. A.; Milakofsky, L.M.; Nicotera, C.L. *J. Chem. Educ.* **2001**, 78, 50.

[2] Comeford, L. *J. Chem. Educ.* **1997**, 74, 392.

[3] Recent fall books have been *T. rex and the Crater of Doom* (Walter Alvarez); *Dark Sun: The Making of the Hydrogen Bomb* (Richard Rhodes); *Atoms in the Family* (Laura Fermi); *Geons, Black Holes, and Quantum Foam* (John Wheeler); *Enough for One Lifetime* (Matthew Hermes); *Madame Curie* (Eve Curie); *Rachel Carson* (Linda Lear); *Hitler's Uranium Club* (Jeremy Bernstein); *Curve of Binding Energy* (John McPhee); and *What Do You Care What Other People Think?* (Richard Feynman).

[4] Spring lists have included *Documents in the Case* (Dorothy Sayer); *Polywater* (Felix Franks); *Too Hot to Handle: The Race for Cold Fusion* (Frank Close); *The Periodic Table* (Primo Levi); *The Prisoner's Dilemma* (William Poundstone); *The Baltimore Case* (Daniel Keveles); *The Thirteenth Element: The Sordid Tale of Murder, Fire, and Phosphorus* (John Emsley); *The Undergrowth of Science: Delusion, Self-deception, and Human Frailty* (Walter Gratzer); *The Same and Not the Same*: *A Literary Illumination of Some Mysteries of the Central Science* (Roald Hoffmann); and *The Pencil: A History of Design and Circumstance* (Henry Petroski).

[5] Kovac, J. and Sherwood, D. W. *J. Chem. Educ.* **1999**, 76, 1403; Wilson, J. W. *J. Chem. Educ.* **1994**, 71, 1019.

[6] Kovac, J. and Sherwood, D. W. *J. Chem. Educ.* **1999**, 76, 1403.

[7] Ealy, J. "NSF ChemWrite Evaluation."