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Reading-Writing Groups for Chemistry Graduate Students: A Three-Year Experiment in Finding the Interesting Thing

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CHAPTER 11

READING- WRITING GROUPS FOR CHEMISTRY GRADUATE STUDENTS

A Three-Year Experiment in
Finding the Interesting Thing

Sara Scheib and Amy Charles

Writing, Even in Science

Their work is the definition of modern, but graduate students in the sciences are more like Johnny Tremain, the silversmith's apprentice, than nonscientists might expect. They train in a primary investigator's (PI) group, competing for favor and honors, and to some extent the PI relies on their experiments and observations for future money and reputation. Through a five-year-or-so apprenticeship leading to a PhD, they learn the techniques, handiwork, and habits of thought of their disciplines and develop themselves as young scientists. Many students

are surprised, though, to find how literary an enterprise science is and how necessary it is for them to learn not just to do science, but to engage in scientific communication. The unit of credit in science, as Latour and Woolgar observed long ago, is the paper: a detailed exposition of “we did this first” is the foundation of future funding, invitations, and promotions.¹ Paper authorship is often a requirement for the PhD and is important on the scientific academic job market.

This is a serious problem for faculty. The etiquette of science generally demands that she who does the bulk of the scientific work write the paper and claim first authorship, and it also demands that faculty, to a considerable degree, stand out of their students’ way, allowing them to write the papers that will be their calling cards as they go off to make their own careers. But students arrive with little or no training in writing or in reading the scientific literature on which their research will build. Compounding the problem is the fact that many faculty have learned to write and conduct literature research by sink-or-swim methods and may not be strong writing or information literacy teachers; such teaching also takes time.

Time, unfortunately, is scarce. “We did this first” is not just a matter of ego. In an oversimplified picture, scientists are always in a race for knowledge, with multiple groups competing at the same research frontier. Most academic science research is competitively grant-funded; grants pay for graduate research assistants, who learn to design and carry out vastly time-consuming experiments and observations. Without their labor, experimental work and publication slow, the group lags, and further research funding becomes increasingly difficult to win. In other words, much depends on grad students’ scientific productivity.

Long Seasons for Science, Short Seasons for Writing

So when PIs tell students it’s time to write up results (quickly, please) and publish, how can students become authors, beyond relying on PIs to coach them? Faculty are often wary of the costs and time away from science that writing courses represent, but one-off workshops may not be immediately useful. Department-wide paper-writing workshops also collect students from many sub-disciplines with their Babel of technical languages and concerns. “How would they read each other’s papers?” is a common question. Some students resort to university writing centers, but find that tutors tend to be unfamiliar with scientific language and the forms and politesse of scientific writing. Complicating the matter is the wariness scientists often have of nonscientists’ attempts at helping them with their work.

At this point the conversation often turns, therapeutically if impractically, to the question of why the graduate students don't just arrive with better writing skills. One answer is that at the undergraduate level, mandatory science-major writing classes can prove difficult to put on the books since they eat up precious major-related credit hours; many faculty would prefer to save the hours for science instruction. Optional courses, however, may not attract enough students to run. An alternative is to incorporate lab-report-based writing instruction into the existing curriculum, since lab reports are one of the few forms of writing required of undergraduate science students. While this sort of program can run successfully,² it depends on devoting significant faculty and TA time to writing instruction (and the ability of the TAs to teach report writing competently) or on the willingness to commit funds and course time to professional writing instructors and graders.³ A serious commitment to improving undergraduate science-major writing is required in any case, and this can be difficult to prioritize in research-intensive departments. Normally, it is graduate students, not undergraduates, whose research and writing are important to grant funding.

If it's difficult to help students with writing, what about help with literature reviews, consideration of the function of the paper, and other information-literacy skills that go into making a scientific paper? Librarians have offered support by defining the information literacy standards for graduate students in sciences. In 2006, the ALA/ACRL/STS Task Force on Information Literacy for Science and Technology produced the "Information Literacy Standards for Science and Engineering/Technology."⁴ Disciplinary societies, too, try to guide faculty in teaching information literacy. In chemistry, for instance, a 2012 joint committee of the Special Libraries Association—Chemistry Division and the American Chemical Society (ACS)—Division of Chemical Information produced the "Information Competencies for Chemistry Undergraduates: The Elements of Information Literacy."⁵ ACS does its best to direct faculty to this help: its Committee on Professional Training encourages instruction in the "effective and efficient" use of the chemical literature⁶ and has incorporated "chemical literature and information management skills" as part of its report *Undergraduate Professional Education in Chemistry: ACS Guidelines and Evaluation Procedures for Bachelor's Degree Programs*.⁷

When it comes to adoption, though, information literacy has faced the same uphill climb that teaching writing has. Efforts have come in the form of stand-alone courses, open seminars, and, once again, by incorporating information instruction into other chemistry courses.⁸ A recent effort at Rutgers University–Newark involved a minicourse taught within a research group by a chemistry faculty member and a physical sciences librarian.⁹ However, this minicourse was resource-focused, involving demonstrations of specialized databases and other resources, rather than conceptual. This engagement with research groups

remains an unusual strategy for teaching library research skills. According to a 2012 study of chemistry librarians at Association of Research Libraries institutions, only 19 percent (or 3 of 16) are providing this instruction through research groups.¹⁰

In the end, the (oversimplified) problem is this: most of the time, the urgency in graduate-student scientists' highly competitive world is about *doing* science, not *surveying and communicating* science. Their training in authorship must accommodate that reality.

At the Writing University

In the Department of Chemistry at the University of Iowa, an R1 institution with celebrated writing programs and over a hundred graduate students in chemistry, the faculty, students, and staff had tried or considered many of the approaches discussed above. One professor took the lab-report approach, routinely grading reports by a well-constructed writing rubric. Another professor occasionally devoted a lecture to writing or visual communication in a large-enrollment (400+) undergraduate chemistry course. Students sought help from campus writing centers, with mixed results. The science librarian routinely spent a class period each semester with the organic chemistry students, and the department's part-time science writer had run two optional undergraduate writing courses, both poorly enrolled.

On the graduate side, some professors had developed scaffolded writing training for their research groups, requiring quarterly reports of graduate students who were not yet writing papers. Others had established journal clubs; all worked individually with students. The science librarian met with the graduate orientation class to give a broad overview of library services, specialized databases, citation management, and source evaluation; however, the students had no immediate use for the information, so further instruction in the form of individual consultations was often necessary. The science writer worked individually with students on papers and applications, but her priority was helping faculty members with grant proposals, and there was concern about the efficiency of her one-on-one teaching. The writer and some faculty members had discussed but not developed formal writing courses for graduate students.

Just Doing It

Against this piecemeal background, in the summer of 2014, we, the science writer and science librarian, teamed up informally to run a reading-writing group

(RWG) for one assistant professor's research group, which comprised several graduate students and an undergraduate. Her most senior student was stuck, trying to finish his thesis and graduate. The professor was herself a highly successful grant writer with journalism experience; she'd worked with and trusted both the writer and the librarian, and she was willing to give outside help a go. In discussing how such a group might run, we set the following rules:

1. The group would run informally.
2. Attendance would not be required at the weekly meetings, which would run for an hour or two. Students had competing demands, including experiments that required their presence. However, commitment would be expected of students who showed up. They would be expected to read whatever papers or other materials the group had chosen for the week and contribute thoughtfully to discussion, helping their peers and being helped in turn.
3. The PI would not attend.

This last was raised uncertainly, but the professor agreed that it would be best if she weren't there. Apart from its saving her time, we all thought the students might be less anxious in the meetings if they weren't worried about impressing her, an insight that turned out to be more important than we expected. If this RWG were successful, we thought, we might roll it out to more research groups, slowly strengthening the writing-and-information-literacy culture throughout the department and allow that culture to spread via the grad students. After this discussion, we two approached our bosses, who gave us leave to try it. If it worked and didn't interfere with our other duties, running the RWG would become part of our jobs.

The Pilot RWG

A few weeks later, in a conference room, we started the first reading-writing group, laying out an ambitious plan to the students around the table. They knew of journal clubs, in which one student summarizes an interesting paper for peers, who then might dissect it, but we weren't going to work that way. Nor was this merely an editing workshop. Instead the RWG would introduce students to the way their scientific community carried on conversations about deeply interesting things across decades and help them begin to see themselves as members of that conversation, rather than students writing reports for professors. In doing so, we would overlap what their PIs were teaching them, but we would dwell on these things for an hour or so a week.

To get there, we would read many papers, new and old, their own drafts and others' published work, including classics in their field. We would discuss

- forms of scientific writing and how they had emerged;
- what one could learn about the scope of a scientific conversation and its members from citations, collaborator lists, and scientific family trees;
- how to use various databases in order to find that information easily;
- how to search the literature for meaningful connections to one's research;
- how to find the things one wanted to say about one's research and tell them in a useful way that respected the conventions of form;
- how those conventions were helpful to readers;
- how scientific images communicate and fail to communicate;
- how to read papers in fields one didn't know with the help of convention, images, sensitivity to rhetoric, and compositional aids such as subheadings; and
- the business of journal publishing.

Along the way, there would be ample opportunity to incorporate concepts from the *Framework for Information Literacy*.¹¹

Students writing about their own work would also come to see how steep the knowledge gradients were between themselves and other chemists, and again between chemists and nonchemists, scientists and nonscientists. They would begin to translate for these various audiences and to analogize, to determine where to teach and how much, and how to do it without insulting a knowledgeable part of an imagined audience.

We had to start, though, by getting to know the students and their work, so we asked them to describe their projects. This turned out to be an extremely useful exercise, one we would repeat almost weekly. In attempting to explain their own work to two nonscientists, one who had some chemistry background and one who did not, they were forced to become plainer and plainer: to teach, and in doing so to confront their own intentions and assumptions, both in their science and in their communication of that science to various imaginary audiences. They had to face the holes in their understanding of their work and their professors' work. They had to deal with our misunderstandings of their explanations as they struggled to speak plainly and free themselves from highly technical phrasing that was the only language they had learned for describing their work. And because in this context we were their students, they were quite open (if sometimes taken aback) when we asked plain-language, fundamental questions about what was important in their stories, how the experiments worked, and why nature went this way instead of that.

In other words, these were not merely lessons in sentence construction, or exercises in box ticking as they filled in the form of the scientific paper: abstract, introduction, methods, results and discussion, conclusion, bibliography, supplemental information, and figures. We really started from the basis of their stories: *What is interesting here and why?* From there, as a group—in part because all the students were engaged in similar research and overlapping projects, sharing a conceptual and technical language—we could assemble the structure of a narrative, ask questions about points that were unclear, raise points that had been missed, and discuss what figures ought to support the narrative. We could discuss whose work the author was building upon, including why and how legitimately (had they used a citation without understanding it?) and what they themselves were contributing to this conversation. Before they revised their work, we could also talk about where they meant to submit their papers and why; who that audience was; what the requirements of the journal were; and who ran the journal. We broke it all back down into communities and audiences to discuss how they could write about their work and be understood and published. These conversations, according to the students, sometimes helped them remember what they loved about science in the first place, but had forgotten in the daily slog.

We found that the heart of the conversations was in the few minutes when the students picked up the marker and began drawing on the whiteboard to explain chemical reactions, trends, and processes. The handoff of the marker became meaningful. In chemistry, drawing turned out to be the real language in which the students were speaking: the image of the scientist drawing on a napkin in a restaurant exists for a reason. When they started drawing, we knew we would get something good: the story of their work, where it came from, and why it was important.

We also found that because their boss was not in the room, the students became the authorities and began practicing that role. They grew less afraid of making mistakes out loud. That is important in sciences in a way that, again, may not be immediately obvious. Because the students are apprenticed to faculty and work on faculty projects, their research experience, sets of techniques, sense of how one does science, and philosophies are shaped by their faculty mentors to the point where the usual parlance is “children,” “grandchildren,” and so on; the relationships are lifelong. There is a constant and sometimes exaggerated awareness of the power that a faculty boss, however friendly, holds over students’ futures. The culture of science is also intolerant of public error in either fact or reasoning; it can be combative in this regard. There is real fear of not being smart in front of bosses and their colleagues. But we two outsiders, the librarian and the writer, had no hold on these students’ futures. Furthermore, if they got things wrong scientifically, we probably wouldn’t know, much less criticize. In other words, the environment lowered the perceived price of fumbling. Now and then

this led to conjecture about what a new experiment might show or what a result might mean in a way that might not have happened had faculty been present, but is very much what doing science is about: batting ideas, even half-baked ideas, around until something exciting emerges. Of course, as we ran the meetings, we had no way to know whether students were saying anything sensible. Their PI would determine that, if the ideas made it out of the room. But they were having practice in talking like scientists with real objects at stake: experiment and publication.

Similarly, we made it as easy as we could for students to begin sharing their work. Rather than demanding full drafts, we made it clear that we could discuss islands of text, outlines, even a handful of ideas to kick around: while retaining a critical sensibility, we tried to create a no-shame environment. It was important to break down the fears students had of showing anything but polished work to other people, and again, we believe our status as non-bosses and nonscientists helped make the RWG a protected place. In talking about papers before they'd written much, students also began to recognize the value of "talking the paper" so that they could clarify for themselves what the story was, who the audience was (often what journals were the targets), and how to organize the telling.

We saw the fruits of these conversations in the revisions students brought back to the group. With their narratives stronger and clearer, we could discuss figures, word choices, alignment of the abstract or introduction with the discussion section, and other details.

The students took to calling the RWG a writing club, and it earned the name in the sense of camaraderie that developed. We were heavily dependent for that fellowship on the relationships among the students, their willingness to lead and help each other, and the culture that the professor engendered within her group. We also found ourselves relying on some of the more perceptive students to straddle cultures and translate our questions into things that sounded more like science to other students.

Although it would be nice to imagine that we had a steady flow of manuscripts coming our way, writing remained difficult for all the students, fear of the blank page was real, and sometimes there simply was not enough data to justify writing. Rather than exhorting them to produce more or shutting down for these blank weeks, we used the time to show and discuss high-quality science communication from Carl Sagan, Marcus du Sautoy, Felice Frankel, Edward Tufte, and others. We spent considerable time on current open-access, copyright, data regulation, and journal affordability issues, as well as questions of who funds scientific research and why. Students dissected scientific images, learning to make a point with each image rather than using the figure as a tray on which to deliver all their data to an imaginary professor. Our own tolerance for these dead weeks also turned out to be important. Although it was easy for us to feel that maybe

the students weren't taking the group seriously or that we weren't doing our job in getting them writing, students routinely said that they found these sessions extremely useful.

Similarly, we learned to tolerate low-attendance weeks. Although we sometimes questioned the value of spending hours of staff time on only two or three students, continuing to show up demonstrated our commitment and encouraged the regulars to keep coming. As it turned out, they talked with other graduate students and their boss about what we had covered, and other students came to us individually on their recommendation. The culture of publication and science communication and an awareness of librarians' expertise did appear to be growing stronger. Faculty, too, were becoming more familiar with what the librarian had to offer them and their students.

In this way, even though there was no syllabus, we found we were engaged in what might be called Roomba pedagogy: the group would turn and go in any direction that looked fruitful, often covering old ground along with the new, and after a year we had covered an area thoroughly enough that students were able to anticipate most of our comments and questions. We had essentially decoupled a seminar from most of the obligations of a formal course while accidentally leaving room for more depth and fellowship than we had imagined possible. Students had turned out successful papers, applications, presentations, competition posters, and the much-anticipated thesis, where the RWG is acknowledged as having been "life-changing."

Ending the Pilot and Branching Out

At that point, we decided it was time to end the pilot group. The announcement was met with dismay (and lunch, which they took us out for), but we and their PI felt it was time for them to use independently what they had learned and transmit it to new group members. We decided to check back in every couple of months to see if they needed a booster and to offer the RWG opportunity to other PIs' research groups.

So far we have run RWGs for six (of twenty-nine) research groups, some jointly when the groups have worked in similar enough areas. Areas have included environmental chemistry, radiochemistry, crystal engineering, chemical education, and biophysical chemistry. We've learned new modes of working with each RWG, reflecting the cultures faculty have instilled in their groups. Some are competitive and hard-driving, even argumentative; some prize orderliness, and so on. We also learned that the RWG dynamic can rely on a single student. Usually that student takes on a facilitative role, but if the dominant student is generating tension, we have learned to go immediately to their PI, and in each

case the faculty member has been very helpful. In general, we have found that our way of working is most fruitful for those who enjoyed a loose approach. The more students look for specific learning objectives to be met within a set time period, the more likely they are to find the group frustrating. This does not seem to us to be a barrier to running RWGs, but it means that a group that learns best this way needs an RWG that delivers such structure.

We have also learned our own limits when it came to running RWGs. One at a time is as much as we find we can handle. When students are highly productive, an RWG can be nearly as much work as teaching a course, and we found that when we ran two in a semester we were overburdened.

Graduate students, too, are under considerable stress, and once in a while an RWG member has confided in us or has obviously been struggling. In these cases, we have gone to the PIs, though we have not discussed how to handle situations in which a student confides but does not want us to share the problem. We have also had one RWG whose PI suffered a debilitating crisis during the group's run, and our closeness with the students allowed us to offer them support and help them finish papers that were near completion.

Finally, to our pleasant surprise, the RWGs seem to have a quietly unifying influence on the departmental culture. We work with students across the department, enriching the writing and information literacy instruction that students receive within research groups and sharing individual PIs' techniques with other groups. Perhaps we are bringing some commonality to the literacy education here.

Starting a STEM RWG

What does it take to start a STEM RWG? Our experience suggests seven ingredients: a science librarian, a scientific-writing coach, supervisors willing to devote staff time to teaching, faculty willing to risk students' time on an informal program, students willing to risk their own time, and a room with a big whiteboard—and trust, which deserves its own mention.

When the RWGs began, the writer and librarian had each been working in the department for about two years and had developed good relationships with faculty by working on faculty projects. In other words, we had already proven to their satisfaction that we were good citizens who understood their work well enough to be at least a little helpful to their students. We had also come to know, like, and trust each other. Likewise, students came to trust that although we were not scientists, we had useful knowledge and also that we cared about them and their progress.

The ability to work with individual research groups has been important to the RWGs' successes. Within the discipline, the research group functions as

a social unit, much like a family, and in ideal situations, the more experienced members of the group provide a great deal of support others.¹² Relying on these existing relationships can make peer mentoring remarkably constructive and successful, as students help each other make the transition to independent scholarship.¹³

We have some advantages, including a librarian who is not only an excellent reader, but whose graduate work in social sciences has overlapped some of our chemical-education participants; she is also highly sensitive to students' anxieties. Our science writer is also a fiction writer with a strong sense of story, an MFA in fiction from the Iowa Writers' Workshop, and a background in the history of science. Are these extras necessary? For the RWGs we have run, maybe so, but we expect that people bringing different writing and information backgrounds to other RWGs will run groups with different strengths.

Barriers to Successful STEM RWGs

The major barriers we have encountered involve disciplinary knowledge and communicating across disciplinary lines. We often fail to understand what aspects of the science are about, and we, students, and faculty sometimes differ in our estimates of how much we need to understand. Likewise, we make unfounded assumptions about what students and faculty know of composition and information use. Since science faculty are neither librarians nor writing professors, it has been important to explain clearly what is feasible within the group and to communicate concretely and realistically what students might gain by the experience. (We have not always succeeded in this.) Fairness is also a chronic consideration, since all grad students within a department must meet the same criteria for comprehensive exams and graduation, both of which involve writing and literature research. Help that is available to RWG students in these high-stakes matters must be available to all.

Finally, criticism has to be calibrated. In the end, the group's aim is to lift some burden from faculty and help the students produce publishable papers and successful applications. Their anonymous reviewers will be critical and sometimes stern, so group members must be honest and articulate about manuscript flaws. While critique can be a painful process for the authors, on-point and well-meant criticism that comes with suggestions for improvement is generally well-received. We find that cookies help. However, students who are sensitive to public criticism may not do well in such an environment, especially where tact is lacking; individual meetings may work better.

Hold on Loosely, but Don't Let Go

Our RWGs have been informal, adjusting to suit participants' needs and schedules. This seat-of-the-pants style does not suit everyone, nor does it suit large groups (more than eight) well. Occasionally, PIs approach us about formalizing the sessions, turning them into courses with syllabi and mandatory attendance. We have so far resisted formalization because we find the groups are most dynamic when students are there because they really want to be there. However, we recognize that staying loose—tolerating variation in student interests and PI wishes—is part of what allows the RWGs to thrive and continue. We try to stay loose in considering format as well. One-off workshops open to all the chemistry graduate students have already spun out of the RWGs, two PIs who have helped foster the RWGs have developed presentation workshops, and formal reading-writing courses may be a reality someday. We suspect *flexibility* is a key RWG ingredient on all sides: staff, student, and faculty.

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