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An Approach to Teaching Scientific Writing

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Scientific writing should not be taught as a formal classroom course. In the best of worlds, scientific writing should be taught, assimilated, and perfected within the mentoring process by which a graduate student inexorably acquires the tools of the trade from his or her professors and more senior peers. Through each term paper, essay exam, lab notebook entry, thesis draft, and those first peer-reviewed papers, the mentor's constant feedback, often snuggled in the comforter of co-authorship, forges the malleable graduate student writing style into the edge of scientific clarity.

It is a pity that such a world does not exist. A more realistic view of academe is a world of too many students, too many projects, too many grant proposals and reports due yesterday, too many laboratory techniques and computer programs to be learned, and too few moments to spend teaching something as time consuming as writing. It is in this more realistic world that I found it desirable to design a course in technical communication for biology graduate students.

Course Content

In this course, we begin by discussing the nature of science in fact and fiction and by exploring the complexity of scientific ethics. But by fare the preponderance of course content is devoted to technical writing.

Two primary forms of written technical communications are taught, the scientific paper and the grant proposal. On a practical level, these were chosen because they are the products that make or break a career in science. More fundamentally, they represent two critical approaches to writing, exposition and persuasion.

In its first couple of incarnations, the course encompassed two additional forms of scientific communications, the platform lecture and the poster presentation. However, as it assumed its present structure there just was not enough time, so these communication skills are now taught separately as part of our seminar series. A two-semester course could cover all of technical communication.

Course Texts

Fine books exist on formal writing, beginning with the venerable Woodford (1) and Turabian (2). Shertzer (3) covers grammar. Fowler (4) and Partridge (5) cover usage. Zinsser (6), Pechenik (7), and Booth (8) cover style and substance. Day (9) and Plotnik (10) cover publishing and editing. These are valuable references to be made available to

students and to the teacher. But no single text yet covers completely all forms of scientific communication in ways that encourage students to appreciate the nuances of the subject.

After several trials, I have found two very traditional texts to provide adequate and appropriate foundations for our considerations, the *CBE Style Manual* (11) and Strunk and White (12). These choices at first blush might seem uninspired or even downright reactionary, but good reasons exist.

The *CBE Style Manual* is, de facto, the basis for many of the constraints and expectations students will encounter in their technical writing. To have all students buy their own copy puts a critical reference on their professional bookshelf.

Strunk and White is not about technical writing, but it is about clear writing. It is a book some students have encountered before and so they are asked to revisit an old acquaintance. Furthermore, we must admit that adopting a text appreciated by our humanities colleagues strengthens our claim to legitimacy as writing teachers. And of course, Strunk and White is a book that everyone who writes should read annually.

Teaching Strategy—Lecture

A backbone for the course is lecture material that sticks fairly closely to the two texts, with supplementary insights from other good books on the subject and the many journal articles published in nearly every subdiscipline of biology. The lecture segments concentrate on three content areas: format, style, and process.

Format and structure cannot be overemphasized in teaching scientific writing, which has a very strict format that is different from what students learned in English composition. The standard structure of a scientific report is well described in the *CBE Style Manual*. However, every journal has its own idiosyncrasies, and there is only one correct format—the one the journal editor expects to see.

Scientific style is next in importance, and both the *CBE Style Manual* and Strunk and White are thoroughly discussed in class. Over and over it is emphasized that the scientific style can be summed up simply in a single concept, "clarity." Other characteristics, such as structural simplicity, accuracy, and precise word choice are means to the end of "clarity."

The best of writing will go unread if the processes of publication and grantsmanship are not understood by the student. If the purpose of writing is communication, it has to be published for communication to be accomplished. I ask the student to consider why in the world should anyone wish to publish his paper or give her money to fund her research?

These are crucial topics and are well suited for the lecture, readings, and discussion format of a typical graduate class. Although one could indeed spend a semester on them, they actually can be covered in a very few lectures, leaving the rest of the course for what really counts.

Teaching strategy—learning to wite by writing

Students do not learn how to write from lectures. They learn how to write from writing. As writers know all too well, the most difficult chore is to begin writing and keep writing. We break down this resistance by forcing writing in class, starting with a few sentences and ending with one-page themes by the end of the semester. In every class, students force themselves to put down some thoughts—any thoughts at the beginning—on paper and under time pressure. Within a very few exercises, they find it is indeed possible to start to write.

These exercises also suggest that the real work of writing is in revision, not in the first transcription. As hard as it is to start to write, it is even harder to realize that hardly anything that you write at first will see the light of day but rather will be revised and revised and revised. Although much maligned, the great benefit of the word processor is just this. Compared to handwriting or typing, word processing requires less author investment in the first words and less effort in their revision.

Review and revision consume 80% of the course. During the semester, each student will write one paper and one proposal. But each is written and turned in for review three times. In a few instances, additional drafts are required. By the end of the class, each student's submission is letter perfect. It is an entirely new experience to the student to have to revise after criticism, but it is the primary experience they will face as scientific writers.

Both format and style are reviewed. In each case the format will be exactly as specified by a selected journal and granting agency (we use the journal *Ecology* and the NSF Dissertation Improvement Grant as models). Deviations from required format by even a misplaced period or inappropriate indentation are always criticized. Style deviations are similarly discussed.

The entire class is involved in the reviews, just as peers would be in the real world of scientific publication. The students follow the standard peer review process of the journal and the granting agency, using the proper forms. Students referee each other's papers in class, write their review comments, and participate with the teacher in discussing them in class with the authors. The critiques are graded to encourage seriousness. After the first draft, the entire class receives copies of all papers and each is reviewed in class in its entirety. Although sometimes painful, the process is good toughening for the often cruel world of anonymous peer reviews. By having the students do their reviews in the classroom and discussing them the same day they were turned in, real time feedback is provided to the student writer. There is no place to run, no place to hide.

Results

Each student, by seeing his or her own paper and proposal through a series of increasingly satisfactory revisions, comes to feel deeply that success is possible. More senior students are urged to use their real data, write a real potential paper, and their real thesis proposal as their class projects. Those who do so are ready to submit their products. Those who make up their topics still know they can follow the now familiar formats when their own studies are ready for writing.

Each course is evaluated by the students at its conclusion, and the courses always seem to play to an appreciative audience. One summer the students were entirely school teachers who just needed another course. By the end they were much enthused with their new-found skills as they realized that they are repeatedly called upon for reports. They also could see the benefits in their own teaching, and a few were inspired to write teaching grants for their schools.

Summary

A course in technical writing, devised for graduate students in biology, emphasized understanding the process of publication and grantsmanship, following prescribed technical format, and developing a clear writing style. Although textbooks and lectures were used, the majority of the course was devoted to the student's writing, criticizing, and revising papers and grant proposals. The basic concept was to provide students with the fundamental content of clear technical writing and to re-enforce these lessons through real examples.

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ways in which scientists understand and explain the systems on which they work. One of the things I did not accomplish as editor was to write on the use of metaphors in biology. We use words, and occasionally an equation, to describe the world as we observe it. This world view is complex and often involves events, processes, or concepts outside previous experience. Physiologists rely heavily on metaphors, but there is a change occurring. We are shifting from mechanical to computational metaphors. Scientists are involved in this shift, and editors must also become involved. The consequences of the cooperation between author and editor on understanding and explaining is immense. In my view this is the sine qua non of CBE.

It has been a privilege to be editor of *CBE Views*. I have met some extraordinary people, whose skills and enthusiasm greatly outdistance mine. Perhaps it is the best job in the entire outfit. Thank you.

Alan Brush