Scientific Writing and Technological Change

Teaching the New Story of Scientific Inquiry

Mya Poe
Julianne Radkowski Opperman

The professional writing of science is a dynamic process that changes quickly with technological change (Gross, Harmon, & Reidy, 2002). In the last 30 years, technological innovations, such as new capabilities in image capture and processing, new tools for large data set analysis, and online, interactive applications for delivering information, have changed how contemporary science and thus scientific communication is created and delivered (Bazerman, 1988; Berkenkotter, 2007; Gross, 1990).

With the transcription of scientific discoveries into research articles and other texts that are shared by the research community, scientific advances build upon or diverge from the work of previous scientists when such texts (and thus discoveries) are taken up and cited (repeated as the standard “lore” of the discipline) (Latour & Woolgar, 1979; Sandoval, 2005). Technological innovations, consequently, have not just shaped how scientific discoveries are made (such as genome sequencing) but also how scientific discoveries are communicated (e-mail and personal multimedia devices).

From our perspective, there are three notable ways that scientific communication has changed with technological advances:
• **The development of faster, more accurate automatic laboratory equipment.** Observing, measuring, collecting, and analyzing raw data are facilitated by computer-aided operation of more advanced equipment that immediately process the raw information and produce graphically enhanced compilations of the data.

• **Vast scientific publication databases.** Prior to the 1980s, a research project's literature search would require access to a science library with printed journals and books; now extensive quantities of scientific publications are available online. Science Citation Index (SCI) alone includes more than 6,000 journals (Garfield, 1996).

• **Digital peer review and electronic submission of research.** Through electronic channels, results of research can be shared with individuals almost instantly. Organizations such as the National Institutes of Health now have completely electronic submissions and reviews of grant proposals, and journal editors can now submit manuscripts easily to reviewers almost anywhere in the world.

Given these new challenges brought on by technological advancement, we find that teaching scientific communication today means attending to the visual, mathematical, written, and even oral components of scientific communication in ways that allow students to critically assimilate these modalities into their own expression of scientific thought (Kress & van Leeuwen, 2001). The National Science Foundation (NSF), the National Academy of Science, and other organizations have long recognized the importance of communication education in the sciences and have encouraged changes in the way that students are educated. With the emphasis on standards-based education in the United States, scientific societies have also articulated goals for the learning of scientific communication. For example, the American Association for the Advancement of Science (AAAS) Benchmarks for Science Literacy (1993) prescribe that students be able to "choose appropriate communication methods for critically analyzing data" (pp. 12D, 12E).

Our teaching experiences with technology have also reinforced our belief that students must learn scientific communication in the context of scientific inquiry and that scientific communication must be taught as an interactive, process-oriented approach with opportunities for revision and peer review (Bazerman & Russell, 1985). Only through immersion in the practice of science do students learn the new tools of scientific research in producing scientific genres.

In this chapter, we explain several major ways that scientific writing has changed given technological advances. We then explain how we have attempted to address these changes in our teaching of scientific writing, for Julianne at the high school level (Greely High School, Maine) and for Mya at the college
level (Massachusetts Institute of Technology, Massachusetts). At each site, we incorporate technology into our teaching as we lead students through the scientific research process. In this chapter, we focus on four areas that we have specifically integrated technology into our teaching—proposal writing, literature reviews, storying research findings, and peer review.

**CONTEXTS**

**Greely High School, Cumberland, Maine**

Greely High School, Cumberland, Maine, is a 4-year secondary school located in a suburb of Portland, Maine. The student population includes approximately 700 college preparatory students in grades 9 through 12. All students are enrolled in a Foundations of Science course in ninth grade that includes basic physics, chemistry, and environmental topics. Two more years of science are required (GHS Course Guide, 2007). Students of all abilities are encouraged to explore science through inquiry. To this end, all ninth grade students participate in the Greeley High School Science Fair as a common assessment. The Science Fair is an academic competition in which “students methodically plan, conduct, analyze data from, and communicate results of in-depth scientific investigations, including experiments guided by a testable hypothesis” (Maine Department of Education Regulation, 2007, p. 7).

At GHS the effort to teach writing in the secondary science classroom arose from a need to increase the depth of understanding students obtain in the high school laboratory. School district data indicated GHS students were less proficient in writing and science than peer populations (Galin, personal e-mail, March 2008). After the New England Association of Schools and Colleges Accreditation (2006) process noted this problem, the GHS mission statement was revised: “Students at GHS will: think critically, write effectively, deliver effective oral presentations” (GHS Mission Statement, 2007). In addition to revising its mission, the GHS school administration adopted a multidisciplinary approach to the teaching of writing. Since 2006 the science department has evaluated student writing in science by focusing on writing related to laboratory work, in particular the Science Fair.

**Massachusetts Institute of Technology, Cambridge, Massachusetts**

The Massachusetts Institute of Technology (MIT) is a 4-year, doctoral granting university in Cambridge, Massachusetts. The student population includes approximately 4,000 undergraduate students and approximately 6,000
graduate students. All undergraduate students are required to take a core set of six classes in math, biology, chemistry, and physics as well as laboratory-based classes in which students have "a substantial role in planning the design of the experiment, selecting the measurement technique, and determining the procedure to be used for validation of the data" (MIT Course Catalogue, 2007). Undergraduates are required to take four "communication intensive" (CI) courses—courses that integrate "substantial instruction and practice in writing and speaking"—during their 4 years at the Institute (About the Requirement, n.d.). Quantitative Physiology, the course profiled in this chapter, is one of these CI courses in the Department of Electrical and Computer Engineering. In Quantitative Physiology, students learn "principles of mass transport and electrical signal generation for biological membranes, cells, and tissues" (MIT Subject Listing and Schedule, Fall 2007). Writing is associated with two projects: an experimental project in a wet lab and a theoretical study using computer simulation. Students work in pairs to complete these projects.

Although MIT has a long tradition of teaching technical and scientific writing, the current Communication Requirement was the result of alumni feedback (Russell, 2002). While alumni felt that they had received an outstanding technical education, they needed more training in writing and speaking to succeed in their professional careers. In response, in 1997 MIT initiated multiyear curricular pilots involving communication education (About the Requirement, n.d.). These pilot programs became the basis for the communication intensive curriculum in effect since 2000 at MIT.