GEOCOMMUNICATION, A CORNERSTONE GRADUATE COURSE IN PROFESSIONAL DEVELOPMENT

Ronald D. Lewis — Department of Geology and Geography, Auburn University, Auburn, Alabama 36849-5305, lewisrd@auburn.edu

Lorraine W. Wolf — Department of Geology and Geography, Auburn University, Auburn, Alabama 36849-5305, lwolf@auburn.edu

ABSTRACT

We instituted the new course "Geocommunication" as one of four required courses in our recently revised geology M.S. curriculum. The course was specifically designed to address our students' needs, especially in the areas of organizing and writing scientific journal articles, thesis proposals, and research proposals. Our underlying goals were to impress students with the importance of communication skills in the geosciences and to help get their professional careers off to a good start.

The course was centered on two major projects: a manuscript for a professional journal and a research proposal. Using data from a short field exercise, students wrote their journal manuscripts one section at a time (Materials and Methods through Conclusion, then Introduction and Abstract). The research proposal was patterned after a thesis proposal or a proposal for external funds; both versions involved fellow students as "external reviewers." The course ended with oral presentations of these proposals.

Students completing the course indicated that it had been successful in improving their communication skills and that the course should be retained in the curriculum. Most of their suggestions for improvement dealt with the topics covered and the relative amount of time devoted to each. When asked to provide a subjective assessment of student improvement attributable to the course, other departmental faculty reported improved writing performance and presentation skills for the majority (but not all) of students who had enrolled.

Keywords: Education - graduate; education - (by) writing and speaking; geology - teaching and curriculum; education - computer assisted.

INTRODUCTION

A geology major asked a visiting member of our College Advisory Council, "What is the most important skill for a student entering the profession in today's market?" The council member, a successful geologic consultant, did not hesitate in his response: "The ability to write." This opinion has been echoed by letters from our alumni in the business world. Moreover, lack of good communication skills in the geosciences (and other fields of science) has been recognized for decades as a widespread problem of critical importance (e.g., Steinker, 1981; Bazerman, 1988; Gopen and Swan, 1990; Keys, 1999; Takao et al., 2002). In spite of the many technical skills expected of young geoscience professionals today, communication is still ranked as a major concern by employers (Heath, 2000a, 2000b).

Attempts to remedy this problem include (1) requiring undergraduates to take writing courses such as English composition and technical writing, (2) including written and oral presentations in geology courses (the "Writing Across the Curriculum" approach), and (3) devising a course within the home department that is devoted exclusively to communication theory and skills. In our case, student communication skills were addressed during a revision of our graduate curriculum. At this level, the most important problem was determined to be text production: the skills needed to generate illustrations and to deliver oral presentations effectively were typically acquired during the program, but text writing posed a more serious and persistent problem. Many students had difficulty writing clear, concise sentences. An equally pervasive problem was text organization at the section/chapter level. In particular, thesis drafts often included interpretations in the "Results" section and introduced new facts in the "Discussion" section. Such problems resulted in an inordinate number of thesis drafts that had to be revised — a frustration for the student, the thesis supervisor, and the committee members. Even the thesis proposal, a required written and oral presentation, served as a major hurdle and impeded progress on the thesis itself.

After discussing the options, the Auburn geology faculty determined that developing our own course would be the most effective solution. We felt that entering graduate students might perceive English-Department requirements as not relevant or as remedial. In contrast, if selected topics (even certain grammar and punctuation conventions) were presented by geologists and using geologic vernacular, these topics might be better received. Furthermore, we agreed with David et al. (1995) that a course devoted entirely to writing would be more effective than relying on writing-intensive courses. The new course would give us more time than would be available in individual graduate, subject-matter classes. It would focus on the processes involved in communicating, rather than on the subject matter, and it would assist students with assigned papers and oral presentations in their other courses, with the theses requirement, and with professional presentations. The new course was to be presented as a course tailor-made for their needs as graduate students and entering professionals; to underscore these concepts, we named it "Geocommunication." It would be one of the few courses required of all graduate students in our program.

COURSE SCHEDULING AND DEVELOPMENT

Although conceived of as a beginning course for entering graduate students, the realities of student enrollment and faculty scheduling at our institution necessitate offering the course once every two years instead of every year. The resulting mix of student backgrounds has advantages and disadvantages, as discussed below. (In our case, the class is tied closely to our requirements for the Master's program, but many of the assignments described below could be modified easily to suit upper-division undergraduate students.)

We selected two books as required texts: *Geowriting: A Guide to Writing, Editing, and Printing in Earth Science*

1. Biographical sketch (not graded).
2. Audience exercise.
3. Paraphrasing/Documentation exercise.

PROJECT 1: THE JOURNAL ARTICLE

4. Working title and Materials and Methods section.
5. Figures for Results section I: Tables, histograms, and line graphs (Microsoft Word and Excel).
6. The Results section.
7. Figures for Results section II: Measured section and photographs (Adobe Photoshop).
8. Discussion and Conclusion sections.
9. Figures for Introduction: Location map and stratigraphic chart (Adobe Photoshop).
10. Practice in writing an Abstract.
11. Introduction and Background sections for manuscript.
12. Abstract for manuscript.
13. The completed manuscript, draft 1.
14. Peer review of Introduction section.
15. Final draft of journal paper.
16. Peer review of completed first draft.

PROJECT 2: THE RESEARCH PROPOSAL

17. First draft of the research proposal.
18. Peer review of first draft.
19. Final draft of the research proposal.
20. Oral presentation of the proposal.

Table 1. Sequence of assignments

(1995), by R. L. Bates, M. D. Adkins-Heljeson, and R. C. Buchanan; and *Elements of the Scientific Paper: A Step-by-Step Guide for Students and Professionals* (1985) by M. J. Katz. In addition to the required texts, we encouraged all students to have ready access to a general-purpose writer's handbook and an unabridged desk dictionary. We recommended that students also consult *Suggestions to Authors of the Reports of the United States Geological Survey*, 7th ed. (1991) by Wallace Hanson. With regard to computer software, we chose Microsoft Word, Excel, and Power Point, and Adobe Photoshop.

COURSE CONTENT

We identified the scientific-journal article and the research-project proposal as the two most fundamental writing products for geology graduate students. Therefore, the course was designed around two major projects: (1) a short manuscript, written in the style of a journal article; and (2) a research proposal comparable to, if not the actual, Master's Thesis proposal. Most individual assignments were component parts of these major projects.

Geocommunication met twice weekly for 75 minutes each session over a 16-week semester. There were a total of twenty separately graded assignments (Table 1); most were completed in a week's time. Additional topics, such as poster presentations and web-page construction, were covered without assignments.

The First 2 Weeks - On the first day, the first writing project was assigned: a one-page autobiographical sketch. This sketch is an existing requirement for our new graduate students and provides a way for faculty to get acquainted with the entering students; in this case, the biographical sketch served the additional purpose of getting an initial sample of each student's writing. The one-page assignment was not graded, and copies were distributed to each class member at the following session to help the class get better acquainted.

Thesis proposal
Thesis
Letters and e-mail
Journal articles
Requests for funding (internal and external)
Assessment reports
Manuscript reviews (peer review)
Book reviews
Books
Oral presentations (internal and external)
Abstracts
Map legends
News releases

Table 2. Anticipated communication products for graduate students and professional geologists.

The first lecture subjects addressed were "purpose" and "audience." As part of the classroom discussion, students participated in listing and discussing the writing products they would be expected to generate as graduate students and as professional geoscientists. This long list (Table 2) was an effective motivating device, and students were reminded that this course was created to help them meet these challenges: as stated in the syllabus, the general course objective was " to empower graduate students with the communication skills necessary to be successful Master's degree candidates and, upon graduation, to advance in their careers as professional geologists." "Audience" and "purpose" were then discussed for each item on the list. Emphasis was placed on meeting the audiences' needs and expectations and on the process of transforming the first draft of a document, which is often writer-based, to the reader-based, final draft. Moriarty (1977) was especially helpful in demonstrating how to address different audiences by varying the topics discussed, sentence structure, diction, and total length of the text. Then students were given a copy of a published journal article reporting the discovery of the conodont animal (Briggs et al., 1983) and asked to write three different summaries, each one-three paragraphs in length: one for an audience of specialists (paleontologists), one for general geologists, and one for the lay public.

The final topics addressed during the first week were writer credibility and the concept of intellectual property. Writer credibility is defined by Anderson (1999) as "your readers' beliefs about whether or not you are a good source for information and ideas." We discussed this in terms of a spectrum of possibilities: from "an opportunity to impress" to the risk of damaging one's reputation. The topic of intellectual property was explored through a discussion of paraphrasing as opposed to plagiarism. A key ingredient of any research project is a thorough literature search of previous work, which must be summarized with proper documentation as background for the reader. Teaching

students how to paraphrase published works can be challenging: the language of science is necessarily precise and scientific terminology cannot easily be replaced or rephrased without losing this precision. We provided the students with examples of plagiarism (with varying degrees of sinfulness) to illustrate the fine line between it and acceptable paraphrasing. Once it appeared that the students understood the difference, we gave them three articles discussing different magnitude estimates for 1811-1812 New Madrid earthquake series in central U.S. and assigned the task of summarizing the controversy.

During the second week, we introduced the structure of the scientific journal article and used two in-class exercises to provide hands-on experience with the component sections (e.g., Introduction, Methods, Results, etc.). The first exercise was a "scavenger hunt" in which each student was given a copy of a short paper, but not allowed sufficient time to read it. Students were then asked to answer specific questions regarding the article (e.g., "What is the objective of this study?" "What sieve size was used to screen for the microfossils?") and to record in which section the information was found. This exercise demonstrated that the location of information within the article is highly predictable once the standard format is understood. The second exercise was a comparison of article organization in different geoscience disciplines. Students were given bound volumes of five different journals, each representing a discipline, and were asked to compare the organization of articles at the section level. Students initially tended to perceive differences, but eventually recognized the common structure. We emphasized that the section-level organization of scientific articles follows a fairly uniform pattern, derived historically from the scientific method, and is so pervasive that readers may become confused if information is not where they expect it to be (Gopen and Swan, 1990). Becoming familiar with this structure would make their own texts both more effective and easier to write.

Project 1: The Journal Article — Weeks 3-11 -To prepare for the first project, the class took a day-long field trip to two nearby exposures of a Cretaceous sandstone. The objectives were to measure and describe the exposures, take photographs, and to collect bulk samples of friable sand as well as other lithologic and fossil specimens. Over the next few days, students dry sieved the loose sand, a task that provided them with at least one set of numerical data. Thus, the initial figures and data for the first project, a scientific-journal manuscript, were generated in short order. In addition, because each student would be working with the same types of data, at least in part, it would be easy to make comparisons among the final products. The next several weeks would be devoted to the systematic generation of a manuscript for a geoscience journal.

The first writing task for this project was to develop a working title and short synopsis of the paper. All students were required to write on some aspect of the exposures visited; many discussed stratigraphic correlation and interpreted depositional environments, but some followed their particular interests by focusing on such topics as fossil content or nodule diagenesis. All papers were required to include numerical data in tabular form, as histograms, and as line graphs (this was the reason for the grain-size analysis). Other required text illustrations were (1) a location map, (2) a stratigraphic correlation chart, (3) a measured section, and (4) at least one photograph.

To clarify and emphasize the different functions of the sections of a geoscience journal article, we treated each component separately. One by one, each section was (1) discussed in class with examples taken from published journal articles in various geoscience disciplines, (2) assigned and written, and (3) returned with the instructor's comments and discussed in class. Discussions included class critiques of volunteered examples, projected for all to see. The order of sections covered essentially followed that of Katz (1985). "Materials and Methods" was assigned first to take advantage of the field and laboratory procedures just completed. Next was the "Results" section, the presentation of facts without interpretations. We also emphasized the effectiveness and economy of tables and illustrations. Detailed, written instructions on using the software (Microsoft Excel and Adobe Photoshop) were provided to get beginners started with the required table, histogram, line graph and photographs. The "Results" section was followed by "Discussion," with emphasis on the difference between these and the rationale for making the distinction (Katz, 1985; Moriarty, 1997). Class discussion included the importance of objectivity in the sciences and the issue of reader expectations. Finally a brief "Conclusion" section was added.

The "Introduction," perhaps the most difficult section to write, was treated next and received special attention. Students were given the option of dividing this part of the text into separate "Introduction" and "Background" sections, based on their paper topics. We reminded them to be especially sensitive to their audience in this introductory material: what did the audience already know and what additional information did they need? Student authors were to "bridge the information gap between the writer and the audience" (Moriarty, 1997). Figures included the location map and correlation chart, which were scanned from published papers and modified using Photoshop; proper citation of sources was discussed.

The "Abstract" was discussed as an important, stand-alone document that should be concise and informative. For practice, we assigned a separate exercise by giving students a copy of a published paper minus its abstract and asking them to write an abstract based on their reading of the paper. In the following class discussion, students were able to compare their efforts with the published abstract with regard to how well the research and main conclusions were summarized. The final steps in completing their own manuscript were to write the "Abstract," "Acknowledgments," and "Reference" sections; to finish the revisions of the other sections; and to compile all components to produce the first draft (due the end of week 9). The students submitted two copies of the first draft: one for the instructor's comments and grading, and one for student peer review.

Student reviewers were to critique the manuscript assigned to them as if it had been submitted for publication and they were external referees and to rate it as: (1) acceptable with no changes, (2) acceptable with their recommended changes, or (3) unacceptable. Because some students are uncomfortable with providing negative comments to fellow students, we gave them the option of remaining anonymous. The reviews were graded, but peer ratings of student drafts

1. Did the writer provide an adequate introduction to his or her scientific problem? Is the motivation for the study or its significance clearly stated?
2. Is there a clear statement of the proposed work and objectives?
3. Is the reader given sufficient background to understand the importance of the project and how the work fits in with previous or ongoing studies? Is there a satisfactory review of the previous work?
4. Is it clear how the objectives will be accomplished (i.e., is the methodology adequate for fulfilling the project objectives)? Does the proposer have access to the equipment and tools necessary to carry out the project?

5a. (FOR THESIS) Is the timetable for completion reasonable? If not, what suggestions can you offer to make it more realistic?

5b. (FOR GRANT) Is the budget reasonable? Is there sufficient detail in the budget to justify the total expense?

6a. (FOR THESIS) Do you have any suggestions concerning the quality or appropriateness of the figures?

6b. (FOR GRANT) Does the scope of the project fit the budget, the proposer's background, and the time allocated for the project?

7a. (FOR THESIS) Are all the references cited in the text included in the list of references? Is there any inconsistent information?

7b. (FOR GRANT) Do you have additional comments or suggestions for improvement?

FOR THESIS: Overall rating: Excellent (in the top 10%); Very Good (top 20-10%); Good (top 30-20%); Fair (top 50-40%); Poor (below average)

FOR GRANT: Overall rating: Excellent (in the top 10% and should definitely be funded); Very Good (top 20-10%, fund if possible); Good (top 30-20%, encourage revision and resubmission); Fair (top 50-40%, the project has merit but is not competitive); Poor (below average; the project needs major revision).

Table 3. Guidelines for peer review of thesis/grant proposals.

did not affect the authors' grades. Students were given two weeks to revise the first draft, incorporating both a faculty member's comments and criteria-based scoring as well as the student-reviewer's suggestions. They prepared the final draft following the actual instructions to authors provided by the Journal of Sedimentary Research and wrote a transmittal letter to the editor.

Other classroom topics discussed without assignments during the preparation of the journal manuscript included (1) an introduction to Geographic Information Systems, (2) professional conduct at meetings and seminars, (3) selected elements of grammar and punctuation, (4) letter and memoranda writing, (5) a comparison of the Master's Thesis format with that of the journal article, (6) the steps involved in producing the thesis, and (7) the types of communication required of consultants and expert witnesses.

Project 2: The Research Proposal — Weeks 10-16 - The second major project, quite distinct from the journal article, was the research proposal. In the ideal case of an entering graduate student, the student would be engaged in developing a thesis topic and preparing the required thesis proposal; thus Project 2 would be timely. In reality, the class also contained some students who were already in the process of writing their thesis proposals and some who had finished this requirement. Following Evans (1991), we chose to have students who had completed their thesis proposals write grant proposals to an external funding agency for a hypothetical project. Both groups of students were asked to develop a series of objectives, do the background literature search, and present a methodology to achieve the objectives. Students writing the grant proposals would have the additional tasks of discussing their ability to handle the proposed research (e.g., related research, previous results, facilities) and developing a budget.

We presented an outline of sections to be included in the research and the grant proposals: (1) a review of pertinent previous work, (2) a clear statement of the thesis objectives, (3) a summary of the methods to be followed and materials required, (4) a timetable for completion, and (5) a reference section. Then students were presented with examples of thesis proposals written by former graduate students and samples of grant proposals written by faculty members.

Unlike the first project, where each section of the manuscript was assigned and evaluated separately before the student compiled the first draft, the second project involved a whole-document first draft and revision only. Peer review was incorporated as an important part of the process, and instructions were provided to guide the student (Table 3). Each student was given one proposal draft to review and was graded on his or her critique. We examined a few proposal first drafts and reviews during in-class discussion. The reviews were returned to the proposer, along with the instructor's comments and grade for the draft. Grades for the revised proposal were averaged with grades for the first draft to determine the final project grade. We hoped that this grading strategy would encourage the students to strive for quality with the first draft, thus enhancing the quality of the final product.

While students wrote their proposal draft, we devoted lecture periods to other topics, such as poster and oral presentations. This portion of the course was scheduled to precede the national meeting of the Geological Society of America (GSA), for which some students were actively preparing. Guidelines for posters published by major scientific societies (GSA and American Geophysical Union) served as the foundation for lecture material and a focal point for discussion. A portion of one class period included a walk around the hallways of the geology building, where we critiqued posters on display. As with earlier assignments, we again emphasized the importance of tailoring a presentation for the audience, this time highlighting the spatial and temporal characteristics unique to a poster presentation. We considered questions such as, "How much information should go into a limited space?" "How much time will the viewer spend at the poster?" and "How can we prioritize information through the use of

color, font size, and position to interest the broadest possible audience?"

Once the proposal drafts and critiques were submitted and returned, each student prepared an oral presentation of the research proposal for the class. Again, we incorporated suggestions provided by the GSA and AGU, and highlighted differences and similarities between written manuscripts, poster presentations, and talks. Our discussion considered a wide variety of possible audiences and settings: professionals at a geoscience meeting, departmental faculty and student peers, a potential funding source, students at the K-12 level or outreach students, and media personnel. We included advice to novice speakers, emphasizing the need for practice and familiarity with content.

Also during the period of proposal revision, we devoted two class lectures to web-page construction and presentation software. Web-page construction was introduced in two sessions in the computer lab. Students followed written, step-by-step instructions to activate their University home pages, modify them using Netscape Composer, import images, and add links to other pages. One class session was devoted to creating slides using Microsoft Power Point. Students were encouraged (but not required) to use this tool in the oral presentations of their proposal.

The final course sessions were devoted to student presentations of the research proposal and critiques of these presentations by class members. To help guide the students with the critiques, we asked them to evaluate the presentations in terms of six criteria: (1) clarity of the project objectives, (2) motivation or significance of the project, (3) adequacy of background information, (4) quality and clarity of figures, (5) appropriateness of methodology, and (6) delivery. The instructor evaluated and graded the presentations based on these same areas. We originally intended to ask students to revise and repeat their oral presentations once they had the benefit of a critique; however, there was not sufficient time. Common problems arising during these presentations included unclear objectives and font sizes or figures that were too small. Additionally, some students concentrated more on presentation "enhancement techniques" than on scientific content, occasionally to the point of distracting the audience. These problems were highlighted in the in-class critiques, which followed each presentation.

ASSESSMENT AND FUTURE PLANS

How successful were we in achieving our course objectives? Most of our original concerns had to do with (1) whether students would react positively or negatively to the new, required course, and (2) how much the students' ability to communicate would be improved. We were also concerned with course content (which subjects to emphasize at the expense of others), with the timing of assignments, and with the overall workload.

During the term, individual student-teacher conferences revealed that some second-year students were unhappy because they were required to take the course; however, other second-year students and all of the first-year students were appreciative of the opportunities the course afforded. Often the second-year students shared their insights and skills with the new students, and most students said the workload was not excessive. In general, the students' reactions to the new course were quite positive. Written comments on the end-of-course evaluation included, "Good class . . . highly recommended", "Excellent course overall", and "Overall, the class was a success." On a post-course questionnaire, all responding students (eight out of eleven) agreed that the course should be retained in the graduate curriculum, although with some minor changes. Almost all of the changes suggested by the students had to do with the topics covered and the relative amount of time devoted to each. Chief among the suggested changes were that (1) less time should be devoted to Project 1 (the journal article) so that more time would be available for Project 2 (the research proposal), (2) literature research methodologies should be included, (3) resume writing and job search strategies should be included, and (4) more time should be devoted to learning how to use software. Particular aspects of the assignments that seemed to work well were (1) the process of completing the manuscript by assigning only one section at a time and (2) incorporating the element of peer review.

We have benefited from the students' opinions on the merit, content, and delivery of the course. With the experience gained from our first attempt, we plan to move more quickly through the first project and increase the time allotted for the research proposal. Although some students suggested that the course be "expanded" by adding new topics or extending the depth of coverage, expanding the available time is not an option. However, we should be able to make better use of classroom time in our second attempt at teaching *Geocommunication*. This might allow us to add some topics, such as research methods, resume writing, and use of selected software packages, as in-class workshops. If time permits, we will require students to give their oral presentations a second time so that they can respond to reviewers' critiques. Throughout the course, we will maintain the emphasis on the production of text and, specifically, on a "components" approach to the manuscript project (seven out of eight students surveyed agree).

Assessing the lasting effects of the course on student performance or the carryover of the course to other classes in the program is difficult, and perhaps premature. Most of the students from the course are still in the process of completing their degree programs. Four *Geocommunication* students completed their thesis proposals within the academic year; two of these reported that the course assisted them in this process. Other students had already completed this requirement prior to the course. Faculty in the department also felt that the course accelerated the progress of some students towards meeting thesis related requirements, especially the thesis proposal. However, from discussions with other faculty, we determined the need to increase further the carryover of communication skills to other classes. As educators, we considered *Geocommunication* to be a success, and we are confident that the course raised student awareness: all students who responded to the post-course questionnaire agreed that the course impressed upon them "the importance the Department's faculty place on written and oral communication skills." If the faculty and the participating students maintain a high priority on good communication products, student performance is bound to improve.

We recommend that a course such as our *Geocommunication* be offered every year for incoming graduate students. As such, impressionable new

students are given two important messages: (1) good communication is of fundamental importance in the geosciences, and (2) their home department cares enough about their future success to get their professional careers off to a good start.

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