Writing Intensive Faculty Development Awards Proposal

Scientific Writing and Peer Review in Chemistry - An Assignment-Based Introduction

A Book Proposal by Rainer E. Glaser, Professor of Chemistry, Department of Chemistry, University of Missouri

Brief Summary of Project

It is the goal of this project to write a book with the tentative title *Scientific Writing and Peer Review in Chemistry - An Assignment-Based Introduction*. The specific aims of the book include the presentation of relevant background information and clear and concise instruction (a) on the writing of the elements of a scientific journal article, (b) on computer-assisted directed searches of primary literature and databases, (c) on working with primary sources, and (d) on writing a full paper and seeing it through the scientific peer review process. In addition, the book will provide detailed descriptions (e) of the structure of the theme-based assignments and (f) of the management of assignment submission and peer review to enable faculty to construct sets of assignments with themes of their own interests. The primary target audience of the book will be upper-division undergraduate students in the chemical sciences. It is the purpose of items (e) and (f) to expand the target audience to include faculty and students in other sciences and perhaps even more broadly to faculty involved with WAC. The sets of assignments and peer review devices developed at MU exemplify the process and will be made available for adaptation.

Primary Goals, Objectives, Purpose(s) of Project

We have been interested in the development, implementation and assessment of new curricula to promote the learning of chemistry in inter- and cross-disciplinary contexts at all levels of college science education for many years. Our activities in STEM (Science, Technology, Engineering and Mathematics) education have been funded by MU, the Dreyfus Foundation, and two grants from the National Science Foundation. Aside from reaching and enhancing the education of thousands of students over the years, our activities resulted in many lectures in regional, national and international settings, in the organization of numerous faculty development workshops (at MU, at conferences), as well as in several publications in journals on science education.

With this background and beginning in early 2009, we have developed an assignment-based curriculum to teach scientific writing and peer review in a writing-intensive upper-division undergraduate seminar on *Scientific Writing in Chemistry* for chemistry majors. The seminar is offered as Chemistry 3700 every spring semester with an enrollment of 30 - 35 juniors and seniors. The 3h-course meets three times per week (MWF), usually in a classroom on Mondays and Wednesdays and in the computer laboratory of the Department of Chemistry on Fridays. Mondays are used mostly for traditional lectures to teach relevant background information for the assignment of the week. Assignments are made in class on Wednesday and a conversational format is used to consider strategies to working the assignment. Students begin to work on their

assignments in the Friday meetings in the computer laboratory with plenty of opportunity for one-on-one instruction and peer-to-peer learning. Assignments are submitted, reviewed and revised in the following week while the students begin to work on the next assignment.

Curriculum Description

The curriculum consists in a framework for the creation of writing-intensive assignments and of rubrics for the evaluation of students' submissions by peer review. The approach combines the need for the instruction of all the elements of disciplined scientific writing with the desired flexibility in the selection of the theme of the course. All assignments and peer review devices developed (SP10 - SP13) are available online along with samples of student submissions (http://faculty.missouri.edu/~glaserr/RG_T_SP13.html). Student teaching evaluations as well as other forms of feedback from students and colleagues attest to the success of the curriculum. Hence, this is a good time to review and refine the background knowledge on scientific writing and peer review, that is, the content of the lectures and the foundations of the framework of the assignment-based curriculum. We have gathered and organized relevant content from numerous sources (textbooks, journals, tutorial web sites, science publishers, etc.) and these materials are currently made available to the students as PowerPoint presentation slides and/or as handouts.

Project Outcomes

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* on the writing of the elements of a scientific journal article based on provided, instructor-selected literature sources: outline; writing simple paragraphs with citation of sources; creating data tables; creating schemes and figures, compiling appendices. Assignments #1 - #4.

* on computer-assisted directed searches of primary literature and databases: web portal to publications of the American Chemical Society (ACS), SciFinder to search all chemistry publications, chemistry related databases (SDBS, spectral data base system for organic compounds; PDB, protein data bank). Starts with Assignment #5.

* on working with primary sources: summarizing, paraphrasing, understanding and avoiding plagiarism; citation and bibliography; publication types; what to read; what and where to publish. Starts with Assignment #5.

* on writing a full paper and the science publication process: instruction to authors; writing a manuscript and submission; scientific peer review; responding to peer reviewers and revision; publication ethics and ethics case studies. Starts with Assignment #8.

* on the structure of the theme-based assignments and on the management of assignment submission and peer review to enable faculty to construct sets of assignments with themes of their own interests.

Project's connections to Campus Writing Program's (CWP) Mission as primary agents in educating students

I have actively participated in workshops and events of the Campus Writing Program over the years and, most recently, I participated in the CWP's inaugural *Invitational Experienced Writing Intensive Seminar* in the spring semester of 2012. I have greatly benefitted from the timely information and quality resources provided by CWP and, most of all, I have very much enjoyed the many stimulating conversations with my peers. I was delighted to have been chosen as one of the recipients of the WI Teaching Excellence Award for 2011-12. The continuing interactions with CWP have been highly influential and, I believe, these connections are manifest in the writing-intensive seminar and the book project in several ways.

To develop students' abilities to reason critically and to solve complex problems all assignments are based on current research and address a timely topic a general interest. Moreover, the sequence of assignments #8 - #11 provides a near-authentic experience of the complexities of the science publication process: preparation of a manuscript (of a full paper), writing of peer reviews, responding to reviewers and revision, and second peer review. We have implemented this curriculum four times and each time with a different theme: Aspirin and Other Painkillers (SP10); Dyes, Indicators & Chemical Sensors (SP11); Soaps, Detergents and Other Ambiphiles (SP12); and Solar Energy and Other Renewables (SP13). This stratagem has been essential to the success of the course both for the students and for the instructor: The students are excited to work on new assignments, to engage with timely and relevant content, to construct connections between the basics learned in courses and cutting-edge research, and to meet the intellectual demands of a challenging curriculum. The change of theme every semester keeps the course fresh and interesting to the instructor: It is impossible for the course to become routine and, in fact, this element of novelty elevates the teaching each and every semester. The novelty of the assignments makes plagiarism a non-issue from the start.

To develop the ability to communicate with clear, effective language in discipline-specific ways is the very purpose of the entire curriculum, of the course and of the proposed book on *Scientific Writing and Peer Review in Chemistry - An Assignment-Based Introduction*. This purpose is reflected in the lectures on background on scientific writing, in the content of the assignments, and the reliance on anonymous peer review to evaluate student work. Moreover and importantly, this purpose also is reflected in the emphasis on small group collaboration throughout the course. Modern research on complex projects often requires collaboration across several groups in various disciplines and perhaps multiple locations. To socialize students for modern research therefore requires instruction in the art of becoming valuable collaborators of a research team.

Peer review is essential to science and the students learn about various forms of peer review in this course. The curriculum exemplifies a path for instruction on the proper conduct of peer review. This instruction begins with rubric-based evaluations of elements of papers and evolves

stepwise all the way to the students' involvement in near-authentic peer review of original research papers. The peer review not only serves as the science-appropriate assessment tool, but peer review also is an excellent form of peer-to-peer learning.

Students are required to work in pairs on all tasks and the partners earn the same grade for their joint efforts. This organizational stratagem helps to alleviate and manage the many sources of stress and frustration naturally associated with meaningful engagement in advanced, near research-level studies. Secondly, the organizational stratagem promotes peer-to-peer learning and ensures reasonable debate to reach consensus when the students collaborate on their assignments and when they jointly prepare peer reviews.

Ways project demonstrates the pedagogical theories of "writing to learn" and "learning to write." At its every core, writing is an exercise in organization and logic. In this curriculum, organization and logic are assigned higher priorities than semantics and style. Thus, "learning to write" takes the meaning of learning to organize background information and new data, to perform logical comparative analyses, to derive reasonable conclusions, and to assess and communicate the significance of the conclusions in the context of current research. The curriculum stresses the benefits of the standard scientific organization (Introduction, Materials & Methods, Results & Discussion, References, Supporting Information), clearly defines the functions of the various elements of a paper (text, schemes, figures, tables, appendices, references), and provides detailed instruction regarding best practices in the placement and sequencing of these elements. Overall, the theme-based curriculum makes students' learning more meaningful, enables students to think more critically, and socializes the students to science research, collaboration and communication.

Itemization of strategies for carrying out project *including a specific time line*

The PI has been negotiating with [redacted] about the publication of the book both for the American market (printed book & ebook format) and the Chinese market (ebook format only, *vide infra*). [redacted] offered a contract with a target date for the first English edition in January 2014 and a target date for the first edition for the Chinese market by May 2014. The "Chinese edition" essentially will be the English version expanded by the addition of a Chinese foreword, a Chinese table of content, a Chinese index, and some Chinese headlines. The additions will be created by a bilingual (Chinese-English) chemist (i.e., graduate student or post-doc) as work for hire and paid for by the publisher. No final decisions have been made about the publisher, and offers might be sought from other publishers.

[redacted]

Budget Justification: Dr. Glaser has been working on this curriculum continuously for four years and this level of commitment will continue. The proposed book project will require a major additional effort beginning in the summer of 2013 and throughout AY13/14. While

sections of the book can be developed as part of normal faculty business during the academic year, Dr. Glaser needs one month of dedicated, focused, and contiguous effort to ensure that the book project will be well-structured from the start. This effort also includes the completion of the negotiations with publishers, identifying and working with the graduate student/post-doc on the Chinese edition, and collaboration with CWP (*vide infra*).

Project benefits to CWP, the University of Missouri (MU), faculty, students, the academic, and/or public community can be expected for several reasons. (1) I expect to continue to teach the writing-intensive seminar at MU. The sets of assignments will grow each semester, and these instructional materials can be used by others as they are. (2) I have taught this same curriculum in courses at the Graduate University of the Chinese Academy of Science (GUCAS) in Beijing every summer since 2010: 06/11-27/10, 1 course; 06/15 - 07/03/11, 2 courses; 05/20 – 06/16/12; 2 courses; 06/17–21/13; 2 courses. The first implementation at GUCAS was exceptionally popular with an enrollment of over 200 students. In subsequent years, I offered two courses (introduction to writing, authoring in chemistry) and this format continues to receive praise from the students and my colleagues at the Chinese Academy of Sciences. (3) The curriculum consists in a framework for assignment-based instruction and this framework offers extraordinary flexibility for the adaptation to new themes and related disciplines at MU and elsewhere. We will promote this approach in faculty development workshops at local, regional and national conferences. (4) MU's CWP will benefit from the promotion of its ideals and from exposure in the US and in China.

Manner in which benefits will be demonstrated

The publication of the book will be the most direct and immediate demonstration of benefits. In addition, we will track whether and how the book is used and shared with faculty at MU and beyond. In future, it will be interesting to see whether faculty will use the framework of this curriculum to create their own theme-based sets of assignments.

Manner of CWP involvement in planning, assessing, and follow up on your project

I am open to and welcome CWP involvement in all aspects of this project. Major opportunities exist is the areas of working with sources (summarizing & paraphrasing, understanding and avoiding plagiarism) and the development of case studies on the ethics of publishing (responsible authorship, responsible conduct of peer review). Columbia University's Responsible Conduct of Research (RCR) project (http://ccnmtl.columbia.edu/projects/rcr/rcr_authorship/) and Yale University's Research Integrity case studies (http://ori.dhhs.gov/yale-university) are first examples of instruction in publication ethics. Developments of instructional materials in publication ethics also could be a starting point for local and regional workshops.