Rethinking the Formal Laboratory Report For Physical Chemistry: Scientific Word and Scientific WorkPlace to the Rescue.

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Introduction:

It has been the tradition for chemistry majors in their junior or senior year to prepare and submit approximately ten formal five to ten page laboratory reports per semester as outlined in Shoemaker et. al. or Daniels et. al. This has been justified to help in understand ing the experiment, and to prepare the student for writing papers and reports in their future careers in academe and industry. Overall this procedure has worked well, but has added significantly to the workload of students and the teaching staff. To be effective, the effort by all is significant. We remember writing these reports as a major chore in our effort to get our undergraduate degree. Some of us may reflect back on surviving this ordeal with pride and still have copies of our formal physical chemistry laboratory reports in our files. Your professor may still have all of your reports on file. I still have selected student reports in my files from approximately 35 years of teaching physical chemistry. A few years ago three unrelated events encouraged me to rethink what I was doing and change my approach to physical chemistry laboratory reports.

1. Professor Martin Farrell of our Politics and Government Department won a copy of Scientific WorkPlace® and ScientificWord® (SWP) as an attendance prize at a professional convention and gave it to me. I have used this as my primary word processor for over five years and have upgraded it twice. The sticker price was over $500. I use it to prepare my notes, exams, solve problems, and prepare transparencies. I frequently complement the calculation capabilities of SWP with a spreadsheet.

2. The College instituted at about the same time writing as a required field of special importance. Students must take English 110 and a writing intensive course in another department, usually the department they major in. This is a common trend for liberal arts colleges such as Ripon. It serves to share the load and responsibility for emphasizing and teaching writing across the campus. The Chemistry Department chose to make our writing course a team-taught one-semester junior level integrated laboratory with formal reports. The physical laboratory was retained, but my responsibility for formal writing was changed significantly. The report load on the student was increased to near the breaking point.

3. I became increasingly aware of new trends in teaching and the need to improve, update, and change the physical chemistry course. Some of my early changes were cosmetic, for example, laboratory partners became laboratory teams.

Physical Chemistry laboratory reports at Ripon College 1996:

After three years of development, the current semester requirement for this year and the past year is that students carry out ten laboratory experiments in teams of two. Data reduction and at least preliminary calculations are carried out on all experiments during the lab period. Each student is responsible as the primary author for one to two experiments. The second team member serves as primary critic and secondary author. The instructor assists the student with learning how to use SWP. He reviews and makes suggestions for improvement on at least one draft. The reports are copied and distributed to the class. A soft binder is provided. When a series of reports are finished, a class symposium is held with the team making a presentation on their experiment. Formal reports are not prepared on the last few experiments in the semester, but the class data is shared and discussed. These experiments are usually high interest experiments, such as x-ray powder pattern experiments or quantum chemistry experiments using Spartan, Gaussian 94, or CAChe.

Hardware and Software:

We have licenses for three student versions and my original upgraded professional version of SWP. One of the student versions runs on a PowerMac®, and the others are operating under Windows 95® on a 486 and two Pentium® based machines. The difference in the student and professional version is not apparent and would become apparent only on long documents. The student version is available through your local bookstore from Brooks Cole Publishing for just over $100, and the professional version is available from TCI for around $500 (I have seen this one discounted). Three manuals are available: an introductory manual, a word processing manual, and a scientific calculation manual. The student edition does not come with complete manuals, but they may be purchased separately. We have moved documents between the IBM compatibles and the Macintosh with some problems. The program was written for the IBM compatibles and runs best on the Pentium based computers. The program is not difficult to use, but it has so much in it that I am still learning how

to use some of the wonderful features. I obtained funds from the Dean of Faculty to purchase some of the software for this project under a faculty development grant.

Scientific Word Processing:

Typing in a report is straightforward, but there are a few traps or pitfalls. The report is printed by TEX® program, and the screen image is essentially what you see, but the preview mode gives a clearer view of what the hard copy will be. A style is selected from a large number of styles including the format for a large number of American Physical Society and mathematical journals. The thesis style of my undergraduate (NDSU) and graduate (MIT) institutions are included. The selected style forces the document into a definite format. You may design your own style. Pull down menus and tool bars are many and powerful. The printing and preview programs fail if you do not have paragraph ends or fail to include text under a section heading. Students are initially frustrated that the program will not let you, without special effort, for example, to put two spaces between sentences. (They accept my explanation that all the word processing programs I have used since 1990 automatically insert the second space.)

Text and mathematical objects (equations) are treated differently. Text is in black and equations are in red on the screen. The speller does not check mathematical objects. Equations are easy to enter and appear in typeset quality form. You may put subscripts on subscripts as physical chemists love to do. We use Windows to bring in graphical objects such as drawings and spectra. The equation editor is easier to use and much more powerful than the equation editors in WordPerfect or Word.

Scientific Mathematics:

The authors of a report on an experiment receive data from the other teams doing the experiment and incorporate these results into their report. This gives the class a more complete understanding of the experiment and associated errors. SWP has the full power of Maple® available. Students use this power to perform calculations and to make tables and graphs. The ability to integrate, find roots, solve differential equations, and solve simultaneous equations is rarely used in preparing reports, but the students become aware of the power of Maple® and use these capabilities to solve more difficult problems. The current version has an interface that allows you to use Mathematica®. When I initially decided to try this change, I also investigated the improved text handling capabilities of the latest versions of MathCad® and Maple® and found them to be inadequate.

Conclusion:

I wish I had made this change years ago. Students are learning more about writing formal reports. The quality of reports is significantly greater. Students are much more enthusiastic about the writing aspects of the course. The direction and amount of effort by students and me has changed and improved. The drudgery of writing a report every week has been lost. This year I am going to give an hour examination on the laboratory to increase the understanding of the experiments.

Acknowledgments:
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Endnotes

1. D. P. Shoemaker, C. W. Garland, et. al., *Experiments in Physical Chemistry,* 1996, McGrawHill Companies, Inc., New York.

2. F. Daniels, et. al., *Experimental Physical Chemistry,* 1970, McGraw-Hill Book Company, New York.

3. R. W. Schwenz and R. J. Moore, *Physical Chemistry: Developing a Dynamic Curriculum,* 1993, American Chemical Society, Washington, D.C.

4. TCI Education Division, ITP Thomson Publishing, Florence, KY 410222-6904, 1-800- 3477707.

5. R. Hunter, S. Bagby, *Getting Started with Scientific Work Place and Scientific Word,* 1996, Brooks/Cole Publishing Company, Pacific Grove, CA.

6. R. Hunter, S. Bagby, *Creating Documents with Scientific Work Place,* 1995, Brooks/Cole Publishing Company, Pacific Grove, CA.

7. D. W. Hardy, C. L. Walker, *Doing Mathematics with Scientific Work Place,* 1996, Brooks/Cole Publishing Company, Pacific Grove, CA.

8. **If you wish to see a sample report, please send me a request.**