AC 2011-1915: ALTERNATIVE LAB REPORTS - ENGINEERING EFFECTIVE COMMUNICATION

Daniel Lepek, The Cooper Union

Daniel Lepek is an Assistant Professor of Chemical Engineering at The Cooper Union for the Advancement of Science and Art. He received his Ph.D. from New Jersey Institute of Technology and B.E. from The Cooper Union. Since joining The Cooper Union in 2009, he has taught more than half the courses in the chemical engineering curriculum. Currently, he teaches the undergraduate laboratory course sequence and the graduate transport phenomena sequence. Recently, he has developed and introduced new elective courses on particle technology and pharmaceutical engineering. His research interests include particle technology, multiphase flow and fluidization, pharmaceutical engineering, modeling of transport and biotransport phenomena, and engineering education. Dr. Lepek is a member of AIChE, ASEE, and ISPE.

Dr. Richard J. Stock, Cooper Union

RICHARD STOCK has a PhD in Chemical Engineering (1987) from West Virginia University and is a Professor of Chemical Engineering at The Cooper Union. He is also the Director of the CONNECT Program, training students in effective communication skills. Prior to joining The Cooper Union in 1994 he worked in industry, notably British Petroleum and Price Waterhouse, and biomedical research, primarily at Carnegie Mellon University. His interests include process design and simulation, as well as biological and biomedical applications of chemical engineering.

Alternative Lab Reports – Engineering Effective Communication

Introduction

For many chemical engineering undergraduate programs, required laboratory sequences allow students to experience hands-on applications of chemical engineering principles outside the classroom. After students have successfully completed their laboratory experiments, their results are analyzed and typically written up as a classic laboratory report [1-2]. In addition, prior to taking their chemical engineering laboratory sequence, many students have been exposed to writing laboratory reports, usually in a chemistry laboratory and/or physics laboratory course. Although writing laboratory reports is a valuable skill, today's engineers are expected to report their results and express their findings in a variety of different forms of oral, written, and visual communication [3].

To help our students develop new and improved skills in effective communication, we have modified our laboratory course sequence to highlight and address different approaches to reporting laboratory results. This new initiative in our senior chemical engineering laboratory sequences provides the students with a range of skill-sets that prepares them to communicate successfully on a professional level in a variety of contexts and environments.

Chemical Engineering Laboratory Sequence

The chemical engineering laboratory sequence occurs in both the Fall and Spring semester of the senior year. In each semester, groups of 2-3 students complete five different experiments. The ten experiments explore a range of unit operations and phenomena. They are:

1. Distillation
2. Drying
3. Filtration (Slurry)
4. Flooding Point
5. Fluid Flow
6. Heat Exchanger
7. Liquid-Liquid Extraction
8. Membrane (Air) Separation
9. Reactors
10. Reverse Osmosis

Since our lecture courses do not have a laboratory component, these experiments consequently complement material previously covered in courses in the curriculum. Therefore, the transport- and kinetics- based experiments are usually completed in the Fall semester, whereas those dealing with separations are completed in the following Spring semester.

The laboratory course meets once a week for four hours and students are given two weeks to complete an experiment. Once the experiment is completed, the students have two weeks to submit a laboratory report or communicate their results in an alternative format.

The Initiative

While still using the classic laboratory report as an anchor for developing students' skills in describing and reporting technical work, we have introduced a menu of alternative formats and contexts to challenge their abilities in expressing their message and understanding the needs of different audiences.

During this first year of implementation, we have used the following reporting modes:

Fall Semester

Experiment Number	Report Mode
1	Classic Laboratory Report
2	Poster Presentation
3	Classic Laboratory Report
4	Memorandum
5	Oral Presentation

Spring Semester

Experiment Number	Report Mode
1	Classic Laboratory Report
2	Poster Presentation
3	Classic Laboratory Report
4	Technical Proposal
5	Oral Presentation

Each of the alternative modes of presenting laboratory data is described in more detail below, as well as, with some of the resources we exploited to help with the initiative.

CONNECT Program

To help with the implementation of this initiative, the department of chemical engineering partnered with our communications program (CONNECT). This was established in 1997 with grants from the Department of Education and the National Science Foundation. Since then it has provided workshops in effective communication to all our undergraduate engineering students in every major throughout their undergraduate studies [4-5].

In addition to providing workshops, the program is a resource of expertise in communication issues. Expert facilitators from the CONNECT program worked closely with chemical engineering faculty in developing the parameters we used to define the report alternatives to the students, in providing seminars on the alternatives, in developing rubrics for assessments and feedback to the students, and in giving critiques and coaching to the student laboratory groups [6].

Laboratory Reports

The laboratory reports that the students submit must be written on the level of a scholarly journal article. The overall goal of the laboratory report is to provide the reader with formal conclusions based on an analysis of the observed data using theoretical and/or empirical relations. The students are required to think critically about their results and present their findings in written form. The laboratory report format has the following sections:

1. Title Page
2. Abstract
3. Introduction
4. Experimental (Methods and Materials)
5. Results and Discussion (may be broken into two sections)
6. Conclusions
7. Acknowledgements (optional)
8. Literature Cited
9. Appendices

Using the Fall semester as an example, the students were required to write two laboratory reports. The first laboratory report, corresponding to their first laboratory experiment, was graded based on both technical content and how well it was presented in terms of a scholarly journal article. The reports were graded and reviewed in depth by their chemical engineering instructor and the students were given extensive written feedback. The students wrote another laboratory report for their third experiment, demonstrating marked improvement based on the corrections and feedback provided after their first report. In almost all cases, the laboratory reports written for the second time showed a remarkable improvement in the clarity of writing, reporting of results, formatting, and the overall quality of the report.

Similarly, in the Spring semester two classic laboratory reports were required. We believe that practicing a variety of reporting modes is very valuable, but the preparation and writing of a classic laboratory report provides a foundation to building skills in preparing other report alternatives. Understanding and developing the ability to prepare a thorough and effective laboratory report as a means to communicate technical information and concepts provides students with the basis for exploring these alternatives.

Poster Presentations

For their second laboratory experiment in the Fall, the students were required to present their results in a poster. They were explicitly told that they may or may not provide a presentation to go along with the poster. Therefore, the poster had to be effective in presenting the experimental results whether accompanied by a presentation or not.

The students were given "free rein" over the design and format of the poster. Although reference articles about improving the impact of a poster were provided, the students were free to choose their own format and color scheme [7]. By not providing a template, the students were allowed to express themselves artistically.

After the posters were submitted and full-sized versions printed, each student group had an opportunity to review their work with a CONNECT facilitator. The facilitator provided a critique in terms of formatting, color scheme, consistency, and how effectively the information was conveyed to a non-scientific observer. The groups were given written copies of these critiques for future reference but the critiques themselves were not used as part of the grade. The chemical engineering instructor of the course evaluated the poster based on its visual presentation, and the technical information on the poster.

In the Spring semester students again prepared a poster presentation of a laboratory experiment. This time their skill at explaining and answering questions about the poster were the focus of the exercise as well as assessing how well lessons from the first poster critique and evaluation have been learned.

Figure 1 is an example of a poster that was prepared:

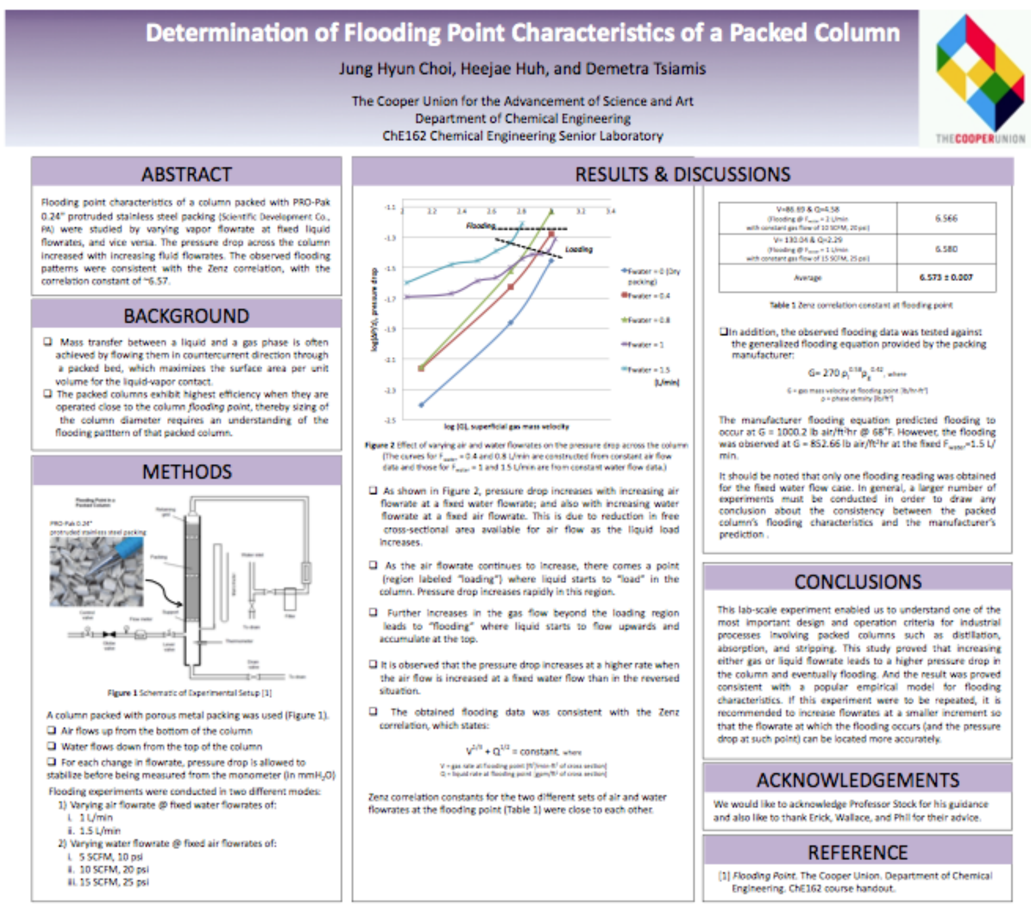

Figure 1: Sample Poster

Memorandum

Students were asked to prepare their fourth report of the Fall semester as a memorandum to a laboratory director. We again engaged a CONNECT facilitator in this exercise and collaborated with the instructor of the first section of our Design sequence in the senior year. A seminar on preparing a memorandum was presented to the whole senior class as part of the Design course. It focused on a detailed exploration of "Memos," including examining aspects such as what kind of document they are, what their purpose was, how that purpose changed with context and with the audience and what are their key characteristics.

The CONNECT facilitator also helped in the preparation of a Memo rubric for aiding in the grade assigned to the reports presented in memo format. The reports themselves were graded by the appropriate instructor assigning 75% of the grade based on the effectiveness of the document as a "technical report" and 25% based on the document working as a memorandum using the rubric.

Oral Presentations

For their final laboratory exercise for the Fall, the students reported their results in an oral presentation. The presentations were 15-18 minutes in length, with 2-3 minutes for questions from the audience. To help prepare for the final presentation, each student group met with a CONNECT facilitator a week before the presentation. The facilitator provided comments and feedback regarding their presentation skills, slide quality, recommendations and other constructive criticisms relating to the presentation.

To assess the quality of the oral presentation, the following attributes of the presenters and their presentations were considered:

Group Dynamics

- Correct division of labor
- Correct division of technical content
- Overall timing of the group's presentation

Presentation/Presenter

- Audibility of speakers
- Readability of visual aids
- How connected the presented is to the audience
- Energy/enjoyment level of the speaker

Technical Content

- Overall technical content
- Descriptions/evaluations of theory/results
- Quality of results presented in visual context
- Answers to audience's questions

The grades that were assigned by the chemical engineering instructor were based on these attributes. Part of the grade was how effective the presentation was on a group level and grades were also assigned for how well each individual participated and contributed to the presentation.

The effective oral presentation of technical material is critical to the professional success of any engineer. Consequently, during the Spring semester, the students were also required to give an oral presentation as part of their final experiment. However, they did not receive coaching during the Spring semester due to their previous exposure to giving oral presentations.

Proposal Presentations

To aid in preparing students to report their results in a proposal setting, we again recruited the help of the CONNECT Program. For this type of report, they presented a seminar to the class on "What Is a Proposal?" Based on the definition: "A proposal is a document that advocates **a course of action** for the purpose of either **solving a problem** or **creating an opportunity**, or both," the class brain-stormed how the results of a laboratory experiment could be developed into a proposal that would fall into that definition for each experiment. This was followed by a discussion of the main elements that make up a proposal resulting in the following outline:

1. Title Page (including title, date, to whom and by whom it is being submitted)
2. Purpose/Summary (a brief statement of the proposed action and a somewhat fuller statement of its significance, that is, what problem or opportunity the action would address)
3. Background (summarizes what has been done to date that has led to the proposed course of action)
4. Solution or Plan (what would be done? how? where?, methods and procedures, expected outcomes)
5. Qualifications (brief bios of the primary team, establishing their competence to carry out the proposed action)
6. Conclusion or Summary

Appendices:

i) Budget (realistic, as complete and detailed as possible, including overhead costs, but also economical, bearing in mind that a proposal may be in competition for funds from other proposals)
ii) Schedule (anticipated dates for each stage of the process and its completion, a variety of timeline and calendar formats are possible)
iii) Personnel (complete C.V.'s for the team)
iv) Facilities (essential information such as square footage, availability of adequate utilities, code and safety specifications, possibly including a floorplan or photos)

The students were given the task of preparing proposals for further work or equipment improvements (or both) based on the results they obtained for the fourth experiment.

Conclusions

The use of alternative ways of reporting laboratory data allowed the students to develop skill-sets in written, oral, and visual communication. The partnership with the CONNECT program provided the students with workshops to critique, develop, and enhance these communication skills. Based on student feedback and the overall performance of the students, we believe that this initiative was successful, and we look forward to developing it for future senior classes.

References

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