Work in Progress: Use of Calibrated Peer Review to Improve Report Quality in an Electrical Engineering Laboratory

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Abstract

This paper discusses the use of a writing exercise in an electrical engineering undergraduate laboratory class in which some of the attributes of the Calibrated Peer Review (CPR) process are practiced. An example of a CPR assignment for an electrical engineering undergraduate laboratory is provided to show how an instructor can potentially modify existing assignments for use with CPR. The results of a "practice CPR" assignment are used to highlight which areas of the CPR assignment preparation need to be given close attention in order to achieve meaningful reviews.

Keywords

Writing Assignments, Calibrated Peer Review, undergraduate laboratory in electrical engineering, memo writing

Introduction

Writing exercises have been included in the upper division electrical engineering laboratory courses since the beginning of our program, typically in the traditional form of the weekly laboratory report. In the late 1990's, influenced by an increasing exposure to the concepts of Writing Across the Curriculum (WAC), Write to Learn (WTL), and Writing in the Disciplines (WID) [1], we began to include memos, progress reports, procedure instructions and final reports, all of which are likely to be used by our students when they are in their engineering jobs, including their co-op jobs. In particular, one of the expected outcomes for all our laboratory courses is for the students to be able to effectively communicate the objective, the design procedure, the experimental results, and the conclusion for a particular laboratory assignment (junior level) or electronic circuit/system design project (senior level).

Current Laboratory Writing Assignments

Different types of writing assignments are used in the final two laboratory classes in our program. In the junior level "Instrumentation Lab", students write three or four "memo reports" which take advantage of the weekly themed experiments in which students are expected to design, build and test one or more circuits that they learned about in prerequisite or concurrent classes. In the senior year "Analog Electronics Lab", structured as a set of three multi-week projects, students complete a narrated slide presentation, weekly (short) progress reports, and two final written reports. Starting two years ago, the seniors also participate in a poster "conference" in which the final design projects of this laboratory together with those of a senior level computer engineering lab, and two other junior level classes are presented to the department's faculty and students.

The memo writing experience for the Instrumentation Laboratory has been in place since fall 1998. The ultimate purpose of each memo is for the students to present the results of their experimental work, their data analysis, and an interpretation of their work in a condensed form suitable to give to a busy boss. With this format, students essentially practice the same skills three or four times during the semester. Students use material from Eisenberg's *Effective Technical Communication, 2nd ed.*[2] to guide their memo writing. Chapter 12 in that text, "Memos and Memo Reports", identifies a set of memo formats suitable for various types of engineering reports, summarizes (codifies) the formats and provides one or more examples of each type. Over the years, the formal assignment document for these memos has evolved from a single paragraph to a more elaborate document in which a scenario for the memo is presented through which motivation and audience is introduced. In addition to the typical due date and formatting information, the assignment document also includes tips for best results that derive from the best (and worst) memos submitted in the past.

This particular type of writing assignments has been in use for about fifteen years in this class. Time is spent in lecture examining both good and bad examples of the entities that are important for successful completion of the assignment. For an active filter writing assignment, these entities include (1) the overall organization of the memo; (2) the need statement; (3) written experimental procedures; (4) graphical and tabular data presentation. The students submit a rough draft which is reviewed by the instructor who provides the student with substantial feedback for improvement. Using this feedback, students rewrite their memos and resubmit for grading.

In general, the products of these assignments are "ok" – some of the memos submitted by the students are excellent, others are marginal. The worst memos are those in which students attempt to explain experimental results which are clearly wrong – the feedback given to these students during the review of initial drafts is that they must redo the experiment. In the last few years, however, the instructor (me) has noted that the format of these assignments is not working to effect <u>improvement</u> in the writing skills of the students. It has been observed that (1) students correct only what the editor has marked even though they were advised that their memo would benefit from a complete rewrite; (2) as the semester progresses, there is no improvement in the quality of the initial drafts. If students were actually engaging with the feedback, it is reasonable to expect that by the third memo, initial drafts would be very good if the goal to make them better writers is being met. Also, it's getting difficult to keep grading memos year after year (after year) and seemingly never seeing any improvement. It is necessary to keep reminding ones' self that the reason it never seems to get any better is because each new semester brings a new – untaught – group of students while the ones just instructed have moved on.

And then, the EBI results from the spring 2015 cohort of students were quite upsetting – our students reported that they did not think they were very good writers. Admittedly, no paper is ever perfect; something can always be improved. But, by the end of the senior year and the third semester of writing work, our students are actually quite good at presenting their technical work – they just don't think so.

And so, the quest to improve student writing continues. In addition to providing students with the experience of communicating the objective, the design procedure, the experimental results, and the conclusion for a particular laboratory assignment, the perfect sequence of writing

assignments will also allow a quantitative demonstration that students are learning to applying self-assessment as part of their writing process as evidenced by initial drafts that are intended to be as close to final as possible.

Calibrated Peer Review – an intriguing possibility

In the fall 2014, I was introduced to the concept of Calibrated Peer Review by the director of the university's Center for Teaching and Learning. I had shared with the director my distress with grading and my dissatisfaction with student progress on the writing assignments, to which he replied, "Have you considered Calibrated Peer Review"? He focused his initial comments to me about Calibrated Peer Review (CPR) exclusively on the possibility of using CPR to reduce my dissatisfaction with the grading process.

Peer review – where students review the work of other students using reviewing guides to provide feedback on content and/or style – is an established technique shown to help students improve their writing skills. Peer review has been used extensively in engineering courses [4-10]. Several aspects of peer review have been identified as roadblocks for successful implementation. One issue is the increased overhead involved in managing the paperwork burden of collecting the initial drafts, assigning and distributing papers to student reviewers, collecting the reviews, collating review results to return to the writers, compiling grades, etc. Other issues focus on the assignments themselves – the quality of the writing prompt as well as the rubrics to be used to review the writing must be appropriately rigorous to ensure actionable feedback, and the reviewers must be trained to provide such feedback. The paper-shuffling aspect of peer review makes it difficult to incorporate peer review into the content of large enrollment classes. Until, that is, Calibrated Peer Review, a software program which "automates the entire process of submitting, distributing, and compiling grades for an assignment"[11]. Fosmire[11] provides an extensive list of references on the use of CPR including papers by the originator, Orville Chapman from UCLA, as well as examples of CPR use in chemistry, medicine, college science, biology, and engineering, from schools all over the nation.

As paraphrased from Fosmire[11] and Carlson and Berry[12], the steps for a Calibrated Peer Review assignment are

> "(1) Students receive a writing assignment, often based on reading(s) selected by the instructor. Students write and submit their essay by deadline to the CPR software server. (2) Students must participate in, and pass, "calibration training" – in which they use a rubric provided by the instructor to grade three instructor-created "calibration" essays. (3) After training, students use the same rubric to grade three of their peers' writings. (4) The student then grades their own writing and their "self-scores" are compared to a weighted average of the peer evaluations to determine if the student accurately evaluates their own work."

To prepare for a CPR assignment, the instructor must create the writing assignment ("assign a writing prompt"[11]), create the grading rubric, develop the grading scale and set the deadlines for each step. The instructor has discretion on the distribution of points and thus the relative emphasis given to each of the four activities listed above. By including both "content" and "style" questions in the grading rubric, the instructor also has the ability to proportion the

emphasis (points) between these categories[11, 13]. While the paperwork paper shuffling burden is lessened with CPR, the creation of the calibration essays, and appropriate grading rubrics/questions imposes a different burden[13] on the assignment preparation stage.

CPR has been used at Purdue[11], Rose-Hulman[12-17], LSU-Baton Rouge [15 -17], North Carolina State University[16], UCLA [15-16], San Jose State[18], the Pennsylvania State University[19], Rice University[20], Texas A & M[21], as well as at Marquette University [22], to name just a few of the over 700 institutions[11] with CPR access. Many of these efforts report writing improvements, as judged by better scores on later assignments and/or self-reported improvement on student surveys. Evidence of enhanced metacognition has also been reported[22]. The report of the use of CPR in an engineering design course[12] seemingly shows that students are capable of "increased discrimination and judgement" over a sequence of assignments where for the last one, students were performing at "near" expert level. It's these last two results which has motivated starting the process to incorporate the use of CPR software in the laboratory writing assignments – in hopes of creating assignments which foster student awareness of the need to automatically applying critical self-editing to their written products. Additionally, the CPR software will enable the instructor to monitor student progress to produce quantitative evidence that students are improving.

"Calibrated Peer Review (CPR) melds the pedagogy of 'writing-across-the-curriculum' with the process of academic peer review."[23] CPR is a web-based writing and peer review tool that automates the process of creating and distributing writing assignments to the students and then manages a peer review process which incorporates both review training and the actual review together with the distribution of the reviews to the writer and resubmission. The institution pays an annual fee to use CPR based on the highest degree offered and the number of students.

In preparation for a CPR assignment, the instructor must design the assignment, create a calibration version of the assignment for three quality levels (low, medium and high quality), as well as the grading rubric to be used by the students in both review training and during actual review. The instructor scores of the calibration versions of the assignment are used during training to provide guidance to the students. From the CPR web site "Overview", "the 'calibration submissions' need to be carefully designed to allow students to learn to identify the errors." CPR provides guidance in this process with examples of assignments as well as a library of existing assignments from which an instructor can choose to use or modify for their own class. The preparation stage for CPR assignments can be quite labor-intensive – complex assignments may require on the order of four to five hours to prepare[13]. However, once the instructor becomes familiar with the process and has developed their own small library of assignments, one can expect that the time involved lessens.

On the path to CPR

Marquette University has joined the Calibrated Peer Review program and our CPR access is administered by the director of our Center for Teaching and Learning. In preparation for using CPR, copies of the existing writing assignments were sent to the director for his feedback on their suitability for use with CPR. During discussion, it was observed that the assignment documents look like they can be easily modified for the CPR writing prompt with the "Tips for best results" sections used to inform the feedback questions (grading rubric). In addition, the

burden of creating the three calibration essays for these assignments could be eased by using the papers for previous versions of these assignments archived on the university's learning management system (LMS), *Desire2Learn* (D2L).

In spring 2015, the CPR program was not used for the Instrumentation Laboratory writing assignments. During that semester, four new sets of weekly lab experiments were developed, with associated on-line lecture materials, to take advantage of both a curriculum revision and a significant upgrade in laboratory equipment. The new experiments also offered the opportunity to create at least one new writing prompt. However, to not totally delay implementing CPR for another academic year, one of the writing assignments was structured in the form of a CPR assignment as a "CPR practice". In that way, a new writing prompt could be tried out, the resulting student submissions could then be used to assist in the development of the calibration versions, and the feedback questions (grading rubric) could also be prototyped.

A condensed version of the CPR practice assignment used in spring 2015 is shown in Appendix 1 for a power supply laboratory. The form of this assignment (writing prompt) is intended to follow the CPR sample assignment format[23]. Comparing previous assignment documents with the CPR practice version, a "scenario section" becomes the much shorter assignment section while the audience and preparation sections remain basically the same. The CPR practice version of "format of memo" section contains an explicit list of what needs to be included in the memo – this information formerly appeared in the scenario section in pre-CPR assignments. The CPR practice assignment also includes a "Tips for best results" section with information on conventions for tables, graphs, and references; this section is not included in the appendix.

The feedback questions for the CPR practice assignment are shown in Appendix 1 – again, the form and content of these questions was motivated by the sample assignment on the CPR website. Questions 1 through 6, 9, and 11 directly probe the bulleted points in the format section of the assignment and deal with the content of the memo. Questions 7, 8, 10, 12, 13, and 14 focus on style issues - formatting of figures, tables, references, use of language, grammar. The last two questions ask the students to rate the report first by declaring the report to be of low, medium or high quality and then to assign a number from 1 to 10 with 10 representing "best".

The submission and review process for this assignment is shown in the "Due Dates" section. There is no resubmission activity for this assignment; nor will there be for any of these assignments even when using CPR. Because the writing assignments in this laboratory all deal with the presentation of experimental results, so that even though the circuits change for each set of experiments, the students continue to practice the same skills of data analysis, presentation of results and interpretation with each assignment. The sequencing of these assignments serves in the role of resubmission with the expectation that students show improved performance as the semester progresses.

Observations from the review process

For this CPR practice assignment, 28 students submitted work and 89 reviews were done. Each submission had at least three reviews. An Excel workbook was developed to catalog the information from the review sheets. A master grid catalogs the grades assigned to a student submission (columns) by their assigned graders (rows). The scores from each question of the feedback are cataloged in individual worksheets, one for each student submission.

The average rating for each grader was calculated to monitor if the students took their review responsibilities seriously. It appears that the majority of students are willing to responsibly do the review - only 4 of the students gave perfect 10's even when their comments or individual question values indicated unsatisfactory performance. The ability of the students to consistently interpret the feedback questions can be assessed by examining the consistency of the grades given to individual submissions; the 75% of the submissions had grades whose range from minimum to maximum was less than two, so it appears (again) that students are mostly on the same page regarding how to review. Based on the number of "no" responses for the individual feedback questions, it seems that students are more willing to apply high standards on style questions; 50/89 reviews noted grammar issues and 33/89 noted issues with the use of technical language.

The instructor also reviewed 17 of the 28 submissions – distributed as one submission from each two person team (14) and then three more chosen at random. The instructor and average student rating for each of these submissions is shown in figure 1 ordered from the lowest to highest values assigned by the instructor.

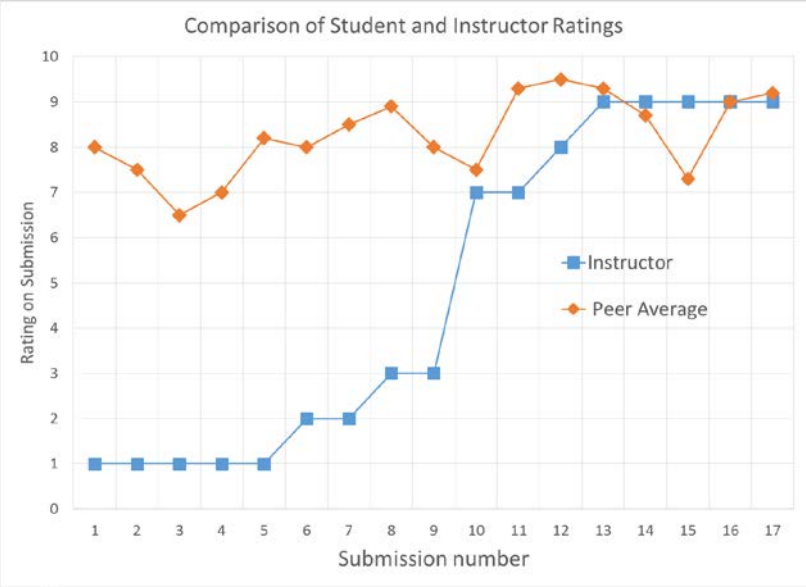

Figure 1: Comparison of Student and Instructor Ratings for the CPR practice assignment

This figure serves to highlight two interesting aspects of this practice assignment. First, it doesn't seem that the students and instructor ratings are at all similar, with students generally giving higher grades. Second, students gave grades in the "normal range" of 7-10 (or 70% to

100%) even when the experimental data were incorrect or the interpretation of the results was faulty as was the case for submissions 1 through 5. This second observation is disturbing because these students should be able to make appropriate judgements on content as they are all doing the same experiments and have seen the same lecture materials.

Next Time

As a practice, this assignment is – in my opinion – a success as it points out where additional work must be done to prepare the CPR assignments. It's clear that the feedback questions need to be revised to add focus on content so that students critically evaluate both original (raw) data quality, the quality of the analysis of the data, and its interpretation. The content questions for this practice assignment could be given positive responses even in the case of bad data which would result in higher scores than merited. The reviewer quality will be addressed through the CPR training – students will not be allowed to assign perfect overall scores unless the assignment truly merits such. And – with the training, it can be expected that grade consistency will be approved.

Summary Remarks

In this paper, a brief introduction to CPR and a set of references that the reader can use to further investigate the use of CPR in their own classes are given. An example of a CPR assignment for an electrical engineering undergraduate laboratory is provided to show how an instructor can potentially modify existing assignments for use with CPR. Finally the results of a "practice CPR" assignment are used to highlight which areas of the CPR assignment preparation need to be given close attention in order to achieve meaningful reviews. It is hoped that all three of these items will be of value to other engineering educators as they incorporate writing into their courses.

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Appendix 1: CPR "Practice" Writing assignment (Spring 2015)

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ELEN 3025 - Writing Assignment # 1
Power Supply –Performance Report

Purpose: Present the results of data acquisition and technical analysis of data in the form of a (short) memo report.

Assignment: Prepare a short report in which the performance benchmarks for both a zener regulated 5 V power supply and a similar 5 V power supply built using an LM7805 IC are compared. The report also details the experimental procedures for both data acquisition and data analysis used to determine the reported performance benchmarks.

Audience: Current ELEN 3025 students. These students will review your report for technical accuracy and quality of the comparison presentation. They will also critique the quality of presentation of the data acquisition and analysis procedures.

Preparation:

Read the materials listed below. These materials are all available in the content section of the ELEN 3025 D2L site.

- In Beer and McMurrey text, A Guide to Writing as an Engineer, 2nd ed., read Chapter 5, pages 91 – 98.
- In Finkelstein text, Pocket Book of Technical Writing for Engineers and Scientists, 2nd ed., read Chapter 9, pages 145 – 165.
- In the Eisenberg text, Effective Technical Communication, 2nd ed. read Chapter 12, all sections except "Listing".

Format of memo:

Based on the assigned reading, choose an appropriate format (outline) to describe the procedure used to measure and analyze the resulting data for one of the performance benchmarks of the DC power supplies you designed, built and testing for Laboratory 6.

At a minimum, your report will contain

- A description of the performance benchmark assigned to you for this memo and how the benchmark is interpreted as a quantitative measure of performance.
- A brief, but complete, description of the data acquisition process. The procedure is to be written as a summary in paragraph form and NOT as a list of steps to be followed. The procedure should also include any variations in the procedure required for the two different supplies.
- Presentation of relevant data in appropriate format (tables, graphs).
- A quantitative analysis of the comparative quality of the two power supplies based on the data.
- Appropriate references (more than just the lecture notes!)

Other:

- Use the power supply data that were acquired during your laboratory work.
- Do NOT include raw data tables unless they lead directly to interpretation of relevant power supply performance benchmarks.
- Do NOT include Grapher figures from Multisim.
- There is no formal limit (or requirement) for the length of this assignment.
  - Estimated length, 1-3 pages (more or less) EXCLUSIVE of figures.
- Be sure that your memo has been proofread for spelling, grammar and typographical errors.
- Use the memo template available on the D2L site – *WA_1_memo_template.docx*.

Due Dates

(1) Memo - Monday, April 13 --- 60 points

Upload an e-copy of your report/memo **as a PDF document**

1. To the dropbox on D2L - "Writing Assignment #1" by 5:00 pm.
2. As an attachment to the thread you create in the "Power Supply" discussion forum in the D2L class site by 5:00 pm
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(2) Grading – Wednesday, April 22 – 30 points
Each student will view and critique (score) **3** reports. The reviews will be submitted IN CLASS on the due date. Each student will complete the WA #1 – Memo Feedback Form for each report that you review and print a HARDCOPY of each review for submission in class. This form contains a series of relevant questions to be used for this review/grading. This form is available from the course D2L site in the writing assignment topic in content.

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Writing Assignment #1: Power Supply Benchmark
Feedback Questions

1. Does the memo describe the performance benchmark to be discussed in this memo? A. Yes B. No
2. Does the memo tell how the benchmark is interpreted as a quantitative measure of performance? A. Yes B. No
3. How was the data acquisition process described in the memo?
A. as a brief summary in paragraph form (in first or third person); B. as a list of steps (as a series of commands); C. there was no identifiable discussion of the data acquisition process.
4. In your opinion, would you be able to use the description of the data acquisition process to duplicate the measurements? A. Yes – well written description; B. Maybe – some minor points were not discussed; C. No – IMO several essential items were not included; Comments: list the missing items
5. Was the issue of whether or not the procedure needs to be varied depending upon the type of power supply tested addressed? A. Yes, but did not describe the changes well; B. Yes, documented the changes appropriately so others can duplicate the work; C. No
6. How were the relevant data presented? A. in the form of one or more tables; B. in the form of one or more graphs or figures; C. No data was presented.
7. In your opinion, was an appropriate data display method used in this report? Describe why or why not
8. Critique the quality of the data presentation. Use the bullets for tabular and graphical presentation in the "tips" section of the assignment document to guide your critique. Comments – provide feedback to help authors improve their data presentation in their chosen method.
9. Is there a quantitative analysis of the comparative quality of the two power supplies based on the data?
10. Is a schematic of the power supply included? A. Yes, and the labels on the schematic are consistent with the surrounding text; B. Yes, but there are discrepancies between the schematic labels and surrounding text; C. No, and one should be included in my opinion; D. No, the schematic is not really needed; Comments – list discrepancies
11. Are there an appropriate number of references beyond the lecture notes included in the memo? A. Yes; B. No
12. Were the references presented in a proper format? A. Yes; B. No; Comments – describe why (why not) the reference format is not proper, what's missing.
13. Critique the use of technical language. A. Occasional (minor) errors in use of technical language; B. No observed errors; C. Exceptionally concise and accurate use of technical language;
Comments: list errors – or – list exceptionally good points in the writing.
14. How well did the memo adhere to the rules of English grammar and spelling? A. Multiple errors – sufficient to distract from content; B. A few errors in grammar and/or spelling – none which distract from content; C. No more than 1 typographical error.
15. Is there an appropriate closure to this memo? A. Yes B. No
16. In your opinion, this report is an A. High quality report; B. Medium quality report; C. Low quality report
17. RATE THIS TEXT
    10 – Highest; 9; 8; 7; 6; 5; 4; 3; 2; 1 – Lowest

~~~~~ End Appendix 1 ~~~~~