122nd ASEE Annual Conference & Exposition
June 14 - 17, 2015
Seattle, WA
Paper ID #14083

Improving student lab report writing performances in materials and manufacturing laboratory courses by implementing a rhetorical approach to writing

Dr. Dave (Dae-Wook) Kim, Washington State University, Vancouver

Dr. Dave (Dae-Wook) Kim is an Associate Professor and Coordinator of Mechanical Engineering in the School of Engineering and Computer Science at Washington State University Vancouver. He has 15 years of experience in engineering materials and manufacturing. His research area includes materials processing, structural integrity improvement, and hybrid composite manufacturing. He has been very active in pedagogical research and undergraduate research projects, and his research interests include manufacturing laboratory pedagogy and writing pedagogy.

Dr. Wendy M. Olson, Washington State University Vancouver

Dr. Wendy Olson is a tenured Associate Professor of English and specialist in rhetoric and composition. She serves as the Director of Composition and Writing Assessment at Washington State University Vancouver, where she teaches undergraduate courses in first-year composition and professional and technical writing, as well as graduate courses in writing studies theory and pedagogy.

Improving student lab report writing performances in materials and manufacturing laboratory courses by implementing a rhetorical approach to writing

Abstract

The act of writing is proven to enhance students' engagement in learning. At Washington State University (WSU), writing skills are identified as an instructional priority. The institution has three writing proficiency requirements for graduation: a first-year composition course, a junior writing portfolio (JWP), and two writing-in-the-major courses. Based upon the scores of JWP (n = 233), we find that our engineering students still struggle to learn the conventions and expectations for writing within the discipline—a common dilemma that other engineering programs face, too. Over the past two years, we conducted an interdisciplinary research effort to improve engineering students' writing skills in two entry-level engineering laboratory courses on engineering materials and manufacturing processes. These lab courses adjusted the view of writing instruction from a traditional modes-based approach to a rhetorical approach, an approach that has been successful in other general education courses. In practice, the course instructor and laboratory adjuncts provided a rhetorical writing review session in the beginning of the semester and graded students' lab reports to provide feedback during the one-on-one sessions. Based on the data collected from multiple years, students' writing quality and their assessment scores were found to improve. This case study of student writing in an engineering material laboratory course was conducted to study the effect of various pedagogical tools on students' lab report scores and their perspectives on writing. Data collected in student surveys and a focus group show that students found one-on-one sessions reinforced their learning from first-year composition courses, identified the expectations of the lab report as a genre, and developed their understanding of the rhetorical features of writing in the discipline of engineering.

1. Introduction

Hands-on learning experiences such as laboratory activities, design projects, and/or capstone projects are the favored experiences of engineering students during their undergraduate education; however, writing reports is often expressed as one of their least favorite experiences. Indeed, engineering students enjoy working with machines, instruments, and numbers rather than words. The reality, though, is that effective written communication is a necessary competency

for engineers because engineers actually spend 20 to 40 percent of their workday writing [1]. For this very reason, the Accreditation Board for Engineering and Technology [2] has addressed in criterion 3g that "an ability to communicate effectively" in the professional contexts is essential for accreditation, and engineering programs nationwide have implemented extensive writing components in their curricular. Although engineering undergraduates are exposed to writing curricula such as first-year composition in their early program of study, they sometimes have difficulties in meeting the expectations of writing within the discipline and in courses in the major (to list a few recent papers, [3,4]).

Washington State University (WSU) has identified writing skills as an instructional priority and established the Writing Assessment Program to support writing instruction throughout a student's undergraduate career. Students are placed into first-year composition course options based on a writing diagnostic (a timed writing exam), and this serves as a lower-division, general education requirement. When they become juniors, students submit a mid-career portfolio, the 'junior writing portfolio' (JWP), to assess their preparedness for the kinds of writing tasks they will be asked to perform in upper-division courses. The JWP includes both a timed writing exam and three graded papers from completed course work. JWPs are evaluated by a trained group of faculty from across the disciplines in the institution. For upper division coursework, students are required to take two writing-in-the-major courses, courses that serve to meet both university requirements for writing and course work requirements for the degree. Recognized by the *U.S. News & World Report* rankings for the last 10 years, WSU's writing in the disciplines program functions as a national leader for prioritizing writing across courses, and for emphasizing a rhetorical approach to writing support wherein students are asked to produce a variety of genres for different audiences and disciplines.

The writing program at WSU is representative of the kinds institutional writing programs that have developed in response to the Writing in the Disciplines (WID) movement. The WID movement, too, has contributed to pedagogical research on lab report writing. The research in engineering education mostly addresses pedagogical strategies and best practices for promoting writing to learn principles. Often, these studies tend to focus on the efficacies of many instructional tools. These tools include tutoring support and automated feedback [3], peer evaluations [5,6], and self-evaluations [7], as well as the implementation of new instructional models such as the HPL (How People Learn) approach [4] and an inquiry-based approach [8], and the development of writing assessment standards and their implementations [9-11]. Most these studies implicitly rely on a "modes" approach, an approach that emphasizes formulas and templates. This approach assumes writing to be a static, mechanical skill [12]. In addition, these approaches did not consider the role of transfer in the development of student writing skills—that is, how students' past experience in writing during their general education courses such as a first-year composition course influence their writing-in-the-major experiences. In our institution, for

example, students in engineering have already have been introduced to the rhetorical situation (writer, purpose, audience, and context), several generic academic genres, and common features of academic writing (developing theses, manipulating sources, using conventions, etc) during first-year composition courses. Engineering students are introduced to this rhetorical approach to writing, an approach that views writing as a dynamic and inventive process that occurs within a rhetorical situation and produces genres, before entering courses in the major. Therefore, we believe that engineering students' writing performances would be significantly improved when transforming engineering writing pedagogy into a rhetorical-based approach to support their writing experience across the disciplines.

This interdisciplinary study focuses on a particular instance of writing in engineering—lab reports assigned in entry-level engineering laboratory courses. While engineering undergraduate students are required to complete writing assignments in many genres, the lab report is often the very first genre within the engineering curriculum that they are assigned after completing their first-year composition course. Therefore, students' experiences with writing lab reports act as an introduction to writing in the discipline of engineering and its attending genres and genre expectations. This is an innovative pedagogical approach because it emphasizes engineering lab reports as a "gate-way" genre into writing in engineering. Therefore, the objective of this study is to provide empirical data on how addressing the rhetorical features of lab reports helped improve students' lab report writing performance. As part of this approach, the instructor conducted one-on-one review sessions and a rubric to reinforce this rhetorical approach. Multiple methods were used to evaluate how effective the students found the curricular changes to their writing performances, including a student survey and a student focus group.

2. Program-level writing assessment of mechanical engineering students.

We have analyzed the Junior Writing Portfolios (JWPs) of mechanical engineering students in our program. As previously stated, students at WSU are required to include three papers from three different classes in the JWP, papers which often include a mix of written artifacts from their first, sophomore, and junior year. After reviewing the JWP assessment results from both electrical and mechanical engineering students (n = 233) over the past three years (2011-2013), we noticed that nearly 20% of engineering students received a "needs work" requirement from the institution's JWP, while other programs on campus show less than 10%. These assessment results suggest that approximately one fifth of our students' best writing samples did not meet university expectations for junior-level writing skills. As a result of this "needs work" assessment, students are required to complete an additional one or three-credit writing course to support upper-division course work.

In order to investigate this trend, we assembled a group of engineering faculty and graduate teaching assistants to assess patterns of writing in the engineering students' writing artifacts. A subsample of mechanical engineering students' JPWs (*n*=18) was evaluated according to four broad rhetorical categories, categories based upon the long-recognized principles (or canons) of rhetoric: invention (the development of ideas with respect to support), arrangement (logical sequence and design), style (control of documentation), and delivery (audience awareness). Given its emphasis on oration, "memory" (the fifth canon) was not included. All writing samples were rated independently by two raters. An extended norming session established both inter-rater and intra-rater reliability among participants, participants who included engineering faculty and graduate teaching assistants who teach writing in the major courses. The rubric used for the evaluation process is shown in Table A-1.

Table 1 shows the overall score of mechanical engineering students' writing artifacts in the mechanical engineering major courses:

Table 1. Overall scores of artifacts (lab reports) in mechanical engineering (Highest = 5)

	Holistic Assessment	Invention and Development	Conventions of the Discipline	Rhetoric of the Discipline	Arrangement and Layout	Knowledge of Writing Conventions and Style
Average	4.1	4.5	4.6	4.1	4.1	3.7
Standard deviation	0.82	0.83	0.49	1.01	0.93	0.89

Overall, there was a high-scoring trend in the development of ideas with respect to support (invention), and understanding of subject (convention). Relatively lower scores were marked for audience awareness (rhetoric), logical arrangement (arrangement) and control of documentation (style). Scores for conventions of the discipline were high with low standard deviations, which means that mechanical engineering students showed their disciplinary knowledge well on the writing artifacts. At the same time, students seem to struggle with knowledge of writing conventions and style in engineering literacy. This category had the lowest average score.

Based on the program-level writing assessment results shown in Table 1, we decided to further our initial study on lab report writing to focus on entry-level engineering laboratory courses. We have chosen entry-level or junior-level engineering laboratory courses because mechanical engineering junior students often decide to include their best lab reports in those courses in their JWPs. The following sections describe what efforts have been made to support a rhetorical approach to teaching lab reports in those courses.

3. Writing assessment of two mechanical engineering laboratory courses

3.1 Laboratory course settings

This study covers two junior-level engineering laboratory courses in the Mechanical Engineering program: Mech 309 Introduction of engineering materials (a writing in the major course) and Mech 310 Introduction to design and manufacturing. Mech 309 or the materials course is a required course for the degree and offered every fall semester. It has six laboratories in materials characterization, mechanical property testing, and microstructure evaluations. All lab sessions require the completion of a lab report. Mech 310 or the manufacturing course is also required and offered every spring semester. It has fourteen laboratories, which include manual and CNC machining, CAD/CAM, and various manufacturing processes such as measurement, casting, injection molding, deformation, and welding. Students need to write lab reports for only the manufacturing processes laboratories in this class. Both classes used the same instructions and guidelines for writing lab reports, which are shown in Appendix A-2 (a modes approach to writing) and A-3 (a rhetorical approach to writing).

3.2 Continuous improvement of students' lab report write-up

The instructor for Mech 309 and Mech 310 implemented many pedagogical tools to enhance the students' writing skills for their lab reports. Table 2 shows the variety of pedagogical changes that the instructor made to support students' lab report writing:

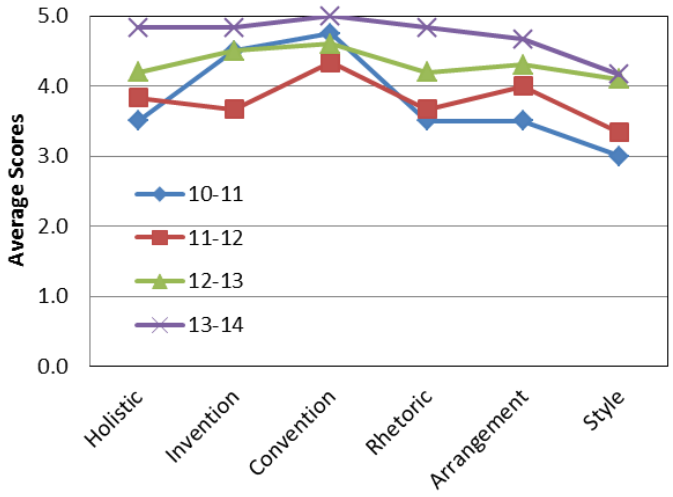
Table 2. Multi-year pedagogical changes made by the instructor

AY	Writing theory	Sample lab report and report guideline	Report grader	Rhetoric writing review session	One-on-one feedback by instructor
2010-2011	Mode	Based on Mode	TA	Not provided	Not provided
2011-2012	Mode	Based on Mode	TA	Not provided	Not provided
2012-2013	Mode	Based on Mode	Instructor	Not Provided	Not provided
2013-2014	Rhetorical	Based on Rhetorical	Instructor	Provided	Provided
2014-2015	Rhetorical	Based on Rhetorical	Instructor	Provided	Provided

Prior to the academic year of 2013-2014, the guidelines for writing lab reports in the courses were written based on a traditional "modes" approach, and it didn't acknowledge that writing conventions and expectations are tied to particular contexts and communities, such as in the field of engineering. After conducting a professional development workshop on rhetorical

approaches to teaching writing in 2013, the instructor started implementing a rhetorical writing pedagogy into the two lab courses. In the academic years of 2010-2011 and 2011-2012, lab reports were graded by a graduate teaching assistant. Since 2013 Fall, the instructor has graded the lab reports and provided a one-hour session on the rhetorical features of engineering lab reports during the first lab session. In addition, the instructor further provided one-on-one lab report feedback sessions for individual students. Each one-on-one feedback session took an average of 10 minutes per student to discuss both the strengths of the lab report and areas for improvement.

Figure 1 shows the breakdown of each academic year of engineering lab report average scores:



AY	Holistic Assessment	Invention and Development	Conventions of the Discipline	Rhetoric of the Discipline	Arrangement and Layout	Knowledge of Writing Conventions and Style
2013-2014	4.8	4.8	5.0	4.8	4.7	4.2
2012-2013	4.2	4.5	4.6	4.2	4.3	4.1
2011-2012	3.8	3.7	4.3	3.7	4.0	3.3
2010-2011	3.5	4.5	4.8	3.5	3.5	3.0

Figure 1. Scores of engineering lab reports for past four academic years (5 max)

These scores are the results from the subsample of mechanical engineering students' JPWs (n=18) identified earlier in this paper. It is a clear upward trend in assessment scores although the results from AY 10-11 and AY 11-12 don't show a clear difference. In particular, style showed an upward trend for four years of observation.

Based on the course level multi-year writing assessment results shown in Figure 1, we decided to focus on one engineering laboratory course (Mech 309 Introduction of engineering

materials) offered in Fall 2014 to study the effect of various pedagogical tools on students' lab report writing skills and their discipline knowledge learning through the labs. These pedagogical changes included revising the lab report writing handout to a rhetorical approach, including a rhetorically-based rubric to accompany the lab report guidelines, and offering one-on-one sessions with students to discuss the lab report as a genre with specific rhetorical features.

4. Results and discussions on rhetorical writing implementation

In order to understand the effectiveness of rhetorical writing approach and various pedagogical tools designed to support students' lab report writing, a case study was conducted on a junior-level laboratory course (Mech 309 Introduction of engineering materials) in the fall semester of 2014. As noted earlier, this class has six materials science laboratories, each of which requires lab report. The instructor first offered a rhetoric writing session before Lab 1. After grading lab reports, the instructor conducted one-on-one lab report feedback sessions with students to discuss the lab reports' strengths and areas for improvement. Results from the direct measurement (the lab report scores) and indirect measurement (student survey and focus group) are presented below.

4.1 Lab report scores

Figure 2 shows the average score changes on five categories of lab report grading. Average report scores from Lab 1 is the lowest of all. This result suggests that students do not have clear understanding of the genre features of lab reports in engineering. They also had lack of information on the instructor's specific expectation for lab reports. After having their first one-on-one session, the average scores went up with Lab 2 reports. This increase performance in lab-report writing clearly shows an upward trend culminating in Lab 6.

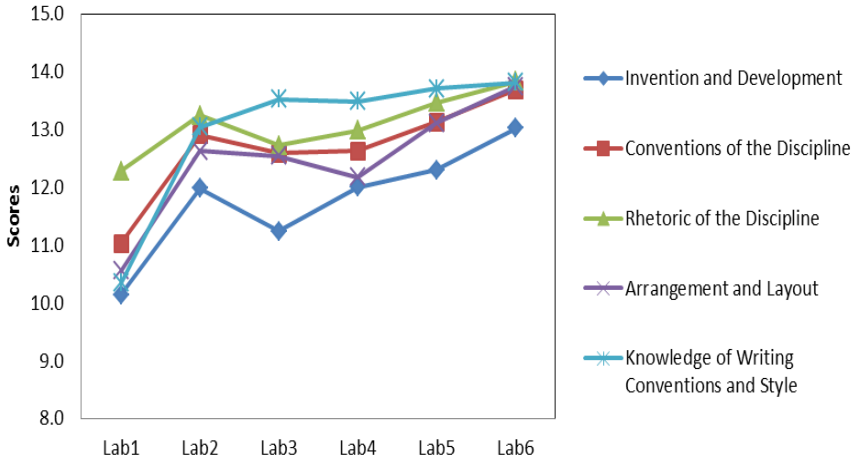


Figure 2. Average scores of each lab report

Overall, students showed clear improvement on the knowledge of writing conventions and style even as early as Lab 2. However, students seem to struggle on invention and development, which required conducting research and bringing ideas and arguments.

The improvement in lab-report writing from Lab 1 to Lab 6 as exhibited by one students' work, Micah (pseudonym), is representative of the above results. In his first lab report, Micah demonstrated a clear understanding of the lab content (experimental design and lab research), yet only adequate understanding of purpose and support in his lab report. As well, his first lab report demonstrates an appropriation of genre conventions, overall organization, and documentation and style. In particular, it includes all required subheadings within the lab report introduction, procedure, results and discussion, conclusion, and references), but sections are under-developed. For example, while he includes an introduction that provides context for the lab, he does not make explicit the significance and/or purpose of the lab experiments scientific contribution. In contrast, his final lab report for the semester (Lab 6) demonstrates improvement in all areas, a move from "adequate" to "successful" demonstration of purpose and support, genre conventions, organization, and documentation and style. Specifically, Lab 6 shows more sophisticated placement and use of tables and figures in that he better situates the visuals within his text and goes into more detailed analysis and explanation of the importance of the data collected in the visual representations.

4.2 Student survey results

During the last week of instruction, all students were given an anonymous survey with eight questions regarding their perceptions on writing in engineering and effectiveness of pedagogical tools used for the class. Table 3 presents the questions and the average scores and standard deviation from the student surveys that were conducted:

Table 3. Questions, average scores, and standard deviations from student survey.

Questions	Average score: 4 max	Standard deviation
1. In your opinion, how important are writing skills for engineering majors?	3.4 (Important)	0.5
2. How prepared did you feel to write engineering lab reports before Mech 309?	2.1 (Somewhat prepared)	0.9
3. How helpful were the lab report handouts when writing your lab reports?	2.7 (Helpful)	0.8
4. The instructor offered one-on-one lab report reviewing sessions. How often did you attend those sessions?	3.6 (All sessions attended)	0.8
5. Did you find participating in the one-on-one lab report reviewing sessions useful for improving your lab report	3.2 (Useful)	0.8

writing skills?		
6. The instructor used a rubric (grading matrix) based on rhetorical writing. How often did you refer to the rubric when writing or reviewing your lab reports?	2.5 (Most times)	0.8
7. If given more than two weeks to complete a lab report, do you think that you would produce a better lab report?	2.3 (Maybe)	1.1
8. Have your writing skills in the engineering field improved through this class's lab report assignments?	3.2 (Likely)	0.7

These results demonstrate that students understand the importance of writing skills for engineering majors while also assessing their own readiness for writing engineering lab reports as low at the beginning of the entry-level lab course. At the same time, students believed that their experiences of writing lab reports during the class improved their writing skills in the major, identifying their participation in the one-on-one sessions as the most useful contribution to improving their lab report writing skills, followed by the lap report handouts and then the rubric, respectively. Students didn't perceive more time-on-task to complete the lab reports as particularly useful. These survey results suggest that students became more confident in their ability to write lab reports as a result of the implementation of rhetorical writing that the instructor made to the classroom. Further, these results suggest that students came to understand the importance of writing skills for engineering majors as a result of this approach.

4.3 Focus group results

The students selected to participate in the focus group represented the diversity of students enrolled in our engineering program: two women, six men, one student of color, one international student, and one older, returning student. Participates were also selected to represent a range of writing skills as demonstrated in graded lab reports. The focus group was conducted by the co-author, an English faculty member from outside of the Engineering Programs.

The purpose of the focus group was to solicit more specific details from students on survey responses. The focus group questions were not given to the participants beforehand and were designed to allow for three types of questions: engagement questions, exploration questions, and exit questions. Focus group questions included the following:

- What did you find most useful and why in supporting the writing of your engineering lab reports?
- What suggestions do you have for improving lab report handouts and/or the rubric?
- What do you understand the genre features of the engineering lab report to be?
- What genre features of the engineering lab report have you improved upon?
- What else, if anything, would you like to add?

In their responses, students uniformly noted that the one-on-one conference sessions with the instructor were the most helpful in improving their lab report writing skills. Students observed that the one-on-one sessions were useful because the instructor highlighted specifics from the draft and provided detailed feedback on both what was working in their lab reports and where to focus on improving for next time. Students appreciated the rubric because it itemized the specific features of the genre and demonstrated the range for understanding where to improve. As shown in Figure 2, the average scores of Lab 2 reports were improved by approximately 15% when compared with Lab 1 reports. Students also noted that the lab report handout was useful because it emphasized a rhetorical approach to writing lab reports by reviewing rhetorical terms (the rhetorical triangle, rhetorical appeals, for example) and then highlighting the rhetorical features of engineering lab reports. They also appreciated that the handout included a list of what was/was not rhetorically appropriate for the lab report genre (no first person, succinct language, for example).

Student responses, too, demonstrated a learned awareness of the genre features of engineering lab reports. In addition to identifying the need for succinct language and the inappropriateness of using first Person ("I") in lab reports, they identified the need to develop background context and to establish the purpose the lab experiment upfront in the lab report introduction. They also discussed both the use and appropriate placement of figures and tables as a feature of engineering lab reports. Of note, they elaborated on the use of figures/tables to emphasize that the type of visual must be carefully chosen and dependent on the kind of data and how it is being used (that is, a table is appropriate in situation X while a graph is most appropriate in situation Y). Students also emphasized the importance of science/data in developing their lab reports, pointing in particular the need to use sources to validate and make credible the results from lab experiments in lab reports. During the focus group, students were able to call upon the rhetorical understanding of writing that they were introduced to in their first-year composition courses, and to talk about genre-specific features of engineering lab reports.

5. Conclusion

This research suggests that students can benefit from a rhetorical approach to teaching lab report writing in engineering lab courses. This study demonstrates that the assessment scores of students' lab reports were found to improve when engineering laboratory courses implemented a rhetorical writing into lab writing instruction. By approaching the lab report as a distinct genre within the discipline of engineering, the discipline-specific features of engineering lab reports are demystified for students. This pedagogical process allows students to better understand the

expectations of lab-report writing, in turn improving the quality and production of their lab report writing skills. When reinforced with one-on-one conferences reviewing the strengths and weaknesses in their written lab reports, the improvement was substantial. This rhetorical approach to teaching lab report writing not only improved student performance, it also improved student learning. The student surveys and focus group show that one-on-one sessions help them to remember their learning from first-year composition courses, identify the expectations of the lab report as a genre, and understand the rhetorical features of writing in the discipline of engineering. By making explicit to students the kinds of writing that happens in engineering contexts and the expectations of writing in the major, students also realized how important writing skills are for future engineers.

6. Acknowledgement

The authors would like to acknowledge the University Research Mini-Grant of WSU Vancouver for the generous support for this research.

7. Reference

[1] Kreth, M. L. (2000). A survey of the co-op writing experiences of recent engineering graduates, IEEE Transactions on Professional Communication, 43:137–52.

[2] Accreditation Board for Engineering and Technology (2006), Engineering Change: A Study of the Impact of EC2000, Executive Summary, http://www.abet.org/papers.shtml.

[3] Calvo, R.A., and Ellis, R.A. (2010). Students' Conceptions of Tutor and Automated Feedback in Professional Writing, Journal of Engineering Education, 99:427-438.

[4] Yalvac, B., Smith, H. D., Troy, J. B., and Hirsch, P. (2007). Promoting Advanced Writing Skills in an Upper-Level Engineering Class, Journal of Engineering Education, 96: 117-128.

[5] Ekoniak, M., Scanlon, M.J., Mohammadi-Aragh, M.J. (2013). Improving student writing through multiple peer feedback, IEEE Frontiers in Education Conference, 626 – 628.

[6] Furman B. and Robinson, W. (2003). Improving Engineering Report Writing with Calibrated Peer Review,The 33rd ASEE/IEEE Frontiers in Education Conference, November 5-8, Boulder, CO.

[7] Smelser, R. E. (2001). How to Build Better Engineers A Practical Approach to the Mechanics of Text. Quarterly-National Writing Project, 23: 32-35.

[8] Sundararajan,S., Faidley,L.E., Meyer,T.R. (2012). Developing inquiry-based laboratory exercises for a mechanical engineering curriculum, 2012 ASEE Annual Conference & Exposition.

[9] Burke, K., Ouellette, J., Miller, W., Leise, C., and Utschig, T. (2012). Measuring Writing as a Representation of Disciplinary Knowledge, International Journal of Process Education, 4: 13-27.

[10] Greco, C., Reasoner, J.D., Bullock, D., Castillo, C.L., Buford, P.S., and Richards, G.G. (2011). Efficacy of Lab Reports for Electric Circuits Laboratory Assessment, Proceedings of ASEE.

[11] Goldberg, R., Caves, K., and Reynolds, J.A. (2011). Improving the quality of writing in a capstone engineering design course, ASEE conference.

[12] Connors, R. (1997). Composition-rhetoric: Backgrounds, theory, and pedagogy. University of Pittsburgh Press.

8. Appendix

Table A-1. Rubrics used for the program-level evaluation process

Score	5	4	3	2	1
	Excellent (A to A-)	Very Good (B+ to B)	Good (B- to C+)	Fair (C to C-)	Weak (D to F)
Holistic Assessment	It has substantial content and clear organization and focus. It presents ideas clearly and even gracefully.	The strengths outweigh its weaknesses. It has solid development and is clearly organized and focused, but it is not as strong as an "excellent" portfolio.	The strengths of the portfolio outweigh the weaknesses, but the development of ideas is not complete, the organization and focus are not clear, and the language is not strong.	The strengths and weaknesses are about equally balanced. The writer has tried to develop ideas, focus the paper, and use effective language, but parts are underdeveloped, disorganized, or confusing. The writing may be too general or predictable.	The weaknesses outweigh the strengths. The portfolio is weak, underdeveloped, poorly focused, and too general. However, errors could be minimal.
Invention and Development	Sophisticated development of central idea, purpose, evidence and support	Solid and consistent development of central idea, purpose, evidence and support	Adequate development of central idea, purpose, evidence and support	Uneven development of central idea, purpose, evidence and support	Incomplete and/or underdeveloped central idea, purpose, evidence and support
Conventions of the Discipline	Shows sophisticated understanding of the subject and high degree of facility with specialized concepts	Shows clear understanding of the subject and facility with specialized concepts	Shows some knowledge of the subject or use of specialized concepts	Shows inconsistent knowledge of the subject or use of specialized concepts	Provides little or no evidence of knowledge of the subject or use of specialized concepts
Rhetoric of the Discipline	Sophisticated use of disciplinary appropriate genre, format, language, tone, and audience awareness	Solid and consistent use of genre, format, language, and tone appropriate to the discipline and audience	Use of genre, format, language, and tone are appropriate to the discipline and audience, but not highly developed	Shows limited use of genre, format, language, and tone are inappropriate to the discipline and audience	Use of genre, format, language, and tone are inappropriate to the discipline and audience
Arrangement and Layout	Successfully develops ideas in a sophisticated logical sequence and design choice	Successfully develops ideas in a logical sequence and appropriate design choice	Adequately develops ideas in a logical sequence and appropriate design choice	Shows difficulty in presenting ideas in logically and with an appropriate design choice	Shows limited understanding of organization and visual design
Knowledge of Writing Conventions and Style	Sophisticated control of documentation, mechanics, and style	Solid and consistent control of documentation, mechanics, and style	Adequate control of documentation, mechanics, and style	Uneven control of documentation, mechanics, and style	Limited and/or lacking control of documentation, mechanics, and style

Table A-2. Lab report guideline example (Mech 310 in Spring 2011) based on a modes approach to writing

Lab Report Format: Mech 310 Lab

Report Structure – Total 100 points

- Title Page (1 page) (see attached example) – 5 points
  - Include
    - Name
    - Date
    - Class
    - Lab name
- Introduction (1-3 paragraphs) – 10 points
  - Summarize what the lab entails
- Experimental Procedures (1-2 pages) – 15 points
  - Elaborate on steps performed in the lab.
  - Define equipment and/or materials used
  - Give all necessary equations
- Results (2-5 paragraphs of writing) – 20 points
  - Explain the experimental results
  - Show all necessary pictures, data, and graphs
- Discussion (1-2 pages) – 20 points
  - Answer all questions provided in the lab handout
- Conclusion (1/2-1 page) – 10 points
  - Evaluate results and comment on their accuracy
  - Provide advice for future labs
- References – 5 points
  - Use APA format
- Appendix (optional)

Lab Content

- Provide clear and sufficient detail in report & answers

Format & Grammar – 15 points

- 12 size font
- Single space
- Space between paragraphs
- Introduction, Procedures, Results, etc… clearly labeled
- Pictures, graphs, diagrams, etc… clearly labeled & formatted

Table A-3. Lab report guideline example (Mech 309 in Fall 2014) based on a rhetorical approach to writing

Sections	**Approximate number of pages/paragraphs**	**Things to write**
Title Page	Use the attached Mech 309 Lab Title Page.	
Introduction	1-3 paragraphs	- introduce background and motivation ofthe lab. (*So What? In*)
Procedure	1-2 pages	- elaborate on steps performed in lab - define equipment and/or materials used - give all necessary equations
Results and Discussion	2+ pages	- explain the experimental results - show all necessary pics, data table, and graphs with proper numbers, titles, axis titles, legends, etc and explain them in the manuscript. - evaluate results and comment on their accuracy - read reference materials to support your claims and compare your data with existing theory or data. - cite references well on the body. - answer questions provided in lab handout (1 thru #) in the manuscript as much as possible.
Conclusion	0.5-1 page	- summarize the findings. (*So What? Out*) - provide a short advice to you if you do this again.
Reference		- evaluate the reliability of sources well before entering them into your report. Source credibility: peer-reviewed journal/magazine articles > books > newspaper articles > internet webs. - highly recommended to find peer-reviewed articles in technical journals or magazines. - use the APA citation style http://www.library.cornell.edu/resrch/citmanage/apa
Appendix		Optional

Formatting and Grammar

- 12 size font, single space
- Space between paragraphs
- Intro, Procedure, Results, etc. labeled
- Tables and Figures well labeled (titles, axis titles, legend, etc).

Lab Report Assessment

All the lab reports will be assessed with the rubric attached on the handouts. The lab report will be graded as a whole document (holistic) and specifically addressing rhetorical features of the lab report genre (invention, convention, arrangement, and style).

Table A-4. Student survey questions

Overview Questions	Please circle one for each question.				
Scores	4	3	2	1	0
1. In your opinion, how important are writing skills for engineering majors?	Very important	Important	Somewhat important	Not important	I don't know.
2. How prepared did you feel to write engineering lab reports before Mech 309?	Very prepared	Prepared	Somewhat prepared	Unprepared	I don't know.
3. How helpful were the lab report handouts when writing your lab reports?	Very helpful	Helpful	Somewhat helpful	Not helpful	I don't know.
4. The instructor offered one-on-one lab report reviewing sessions. How often did you attend those sessions?	All sessions attended	Most sessions attended	Less than half attended	None attended	I can't remember.
5. Did you find participating in the one-on-one lab report reviewing sessions useful for improving your lab report writing skills?	Definitely useful	Useful	Somewhat useful	Not useful	I don't know.
6. The instructor used a rubric (grading matrix) based on rhetorical writing. How often did you refer to the rubric when writing or reviewing your lab reports?	Always	Most times	A few times	None	I can't remember.
7. If given more than two weeks to complete a lab report, do you think that you would produce a better lab report?	Definitely yes	Yes	Maybe	No	I don't know.
8. Have your writing skills in the engineering field improved through this class's lab report assignments?	Very likely	Likely	Somewhat likely	Not likely	I don't know.