Bringing Writing into the ECE Laboratory

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Abstract

Drexel University has instituted an across-the-board policy requiring all students to complete three Writing Intensive (WI) courses after their freshman year. The freshman and sophomore years at Drexel, called The Drexel Engineering Curriculum (TDEC), are an integrated experience in engineering, science and humanities. Two of the courses must be within the student's major, while the third can be in any discipline. Presently, there are over 200 WI classes at Drexel.

Undergraduates, representing all majors are trained and paid peer tutors who work with 10-15 students in a specific writing intensive class. Peer tutors read drafts of student writing. One of the hallmarks of the program is that it is not housed in the English Department. Because of its location within the University's Honors Program, the program's dual mission is to create a culture of writing at Drexel.

The ECE Department has decided to exceed the minimum of two writing intensive courses within the CE and EE degree programs by changing four lab and design oriented courses to the WI style. The ECE WI courses are required for all EE and CE students, with the exception of some bachelors-masters students. In this paper we will describe how ECEL 301, a third year laboratory course, and ECE 491, the first quarter of Senior Design, were modified to meet the new requirements. Changes to course schedules and assignments as well as the development of writing assessment tools have been required. End-of-term assessment tools will be modified to collect feedback on the effectiveness of the program.

Introduction

Writing is an important part of a young engineer's education. All engineering programs address this to satisfy ABET's Criterion 3g, "an ability to communicate effectively". The first year of Drexel's TDEC program in engineering culminates in a freshman design project requiring about 30 pages of writing. In our ECE Department, we get additional impetus from our co-op employers and Advisory Council. Recent changes in graduation requirements and the creation of a University-wide writing program housed in the University Honors Program at Drexel University have offered new opportunities to engineering departments to raise the level of the communications skills of their students.

Engineering programs have used their lab courses to improve written communications in different ways, from linking to existing university writing programs[1], to hiring tutors[2], to

developing their own writing program within the engineering department[3,4]. In all cases, the writing personnel are usually graduate students from writing programs or writing professionals.

Drexel University is one of three schools nationwide with a comprehensive cooperative education program. The results of a 2000 coop employer survey indicating that only 54% of Drexel students received high ratings on their written communications skills brought the matter University-wide attention. A task force of 15 faculty members concerned with student writing formed to research Writing Across the Curriculum Programs. After reviewing a number of successful approaches, Task Force members decided upon a model developed at Brown University[5] and refined by Swarthmore College[6] in which undergraduates are required to take three Writing Intensive courses for graduation.

At Drexel, Writing Intensive courses are those in which 12-15 pages of writing are assigned each term. A term is ten weeks long. Additionally, opportunities for revision are available. Professors may review student drafts or they may choose to employ paid student tutors.

The title, "tutor" has been a controversial one, because of the implication that the tutor is the expert writer. Writing Intensive Tutors (WITS) are trained for this work in a three-credit hour class, but this training differs from what one would expect. Tutors are not trained to become grammarians or even expert stylists. Instead, their training concerns what conditions must be present for good writing to occur and how to best create those conditions. Tutors learn that writing is a process and that good writing is usually that which has been revised. They learn that rules and taboos often reiterated year after year in school inhibit creativity. They learn that clear directions, feedback, and freedom from failure facilitate learning environments.

Although numerous professors choose not to employ peer tutors, we have found that their use is key to the success of the Writing Program at Drexel. This is so because interactions with peer tutors enable students to take responsibility for their writing in ways that teacher-student interactions cannot. Peer interactions set the stage for increased student participation. Professors who are unprepared for sharing classroom authority with WITS often come to realize that students become more involved with their writing when WITS are utilized.

In this paper we present a context for writing as a model for student development in technical skills. We have found that the more interactions students have with writing tutors, the more open they have become to writing in the engineering process. We discuss how standardized writing rubrics facilitate understanding and take the guesswork out of completing an assignment. The most difficult part of integrating writing with engineering content is the added time professors must allow for students to present drafts. We argue that this time is well spent and that it constitutes the difference in helping students to become comfortable with the material. A model of the writing intensive version ECE Laboratory will support our premise that the developmental effects of teaching writing facilitate learning.

ECEL 301 ECE Laboratory I

The ECEL 301 course is the first in a series of four labs required of all EE and CE students. It is a third-year course in the typical 5-year curriculum with co-op. ECEL 301 is the sixth lab-related

course in the student's career, and the first within the ECE Department. The course goals are shown in Table 1, and revolve around learning computer tools that will be valuable in the upper-level curriculum. More detail on the course can be seen on the course web site[7].

Table 1. ECEL 301 Course Goals

- Introduce students to MATLAB and PSpice, industry standard CAD software for electronics (analog and digital) and systems engineers. Use of this software will continue in ECE Labs II-IV as well as other ECE courses
- Solve dc bias, dc sweep, ac sweep, and transient problems in PSpice and MATLAB
- Execute some simple circuit designs using these same concepts
- Perform measurements on devices and circuits
- Raise student's capabilities in technical writing

The course structure has one lecture hour and two hours of lab per week over a 10-week quarter. In that time we do nine lab exercises. Personnel involved included a lab TA, a grading TA, and the instructor. For fall quarter 2004-05, the class had 32 students divided into 3 lab sections. In other terms this course could be twice this size.

The fall 2004-05 quarter was the first time ECEL 301 was taught as Writing Intensive, and was done without Writing Intensive Tutors (WITs) so that the instructor could get a better feel for the range of ability of the students and the workings of the WI process. Each lab group (2 students) was graded for technical content and writing style by the instructor two times, rotating through the sections one per week for weeks 2 through 7.

Since the concept of Writing Intensive courses is new to students, more so at Drexel, a university committed to technical education, it is reviewed in the first lecture. (Put in here, the reactions of the students and how you predict they will change) A section of the course web page is devoted to writing lab reports, and includes a description of the desired contents of each section of a lab report and the required formats for tables and figures. References were provided to the American Psychological Association (APA) and IEEE style guides. The report format used a memo to the student's "manager" as a cover page, with the remainder of the report using the more standard format. The purpose of the memo was to give students some experience in moving between genres. The memo was expected to concisely present the actionable results and conclusions of the experiment; for example, to justify which of two operational amplifiers was more appropriate for a particular application. Individual students wrote reports, with data, PSpice schematics and MATLAB code shared within their group.

After an examination of lab grading practice at other schools, a decision was made to follow an analytic rather than a heuristic rubric. The rubric and grade sheet followed in style and substance ones from Michigan Technological University[8,9] and South Dakota State University[10], and evolved slightly during the quarter.

Each student received a copy of the grade sheet with extensive written comments. Minimal markup was done on the original document. All students were invited to revise and resubmit

their lab within one week for re-grading. The higher grade was kept. In a given week 1/2 to 2/3 of the labs would be returned for regarding. Reports with grades above 18/25 generally were not returned.

The ECEL 301 lab sections showed a small average grade improvement from the first writing assignment to the second. Our first end of term course evaluation recorded a significant improvement in the student's self-assessment of their ability to write a technical lab report (Table 2).

Table 2. Self-Assessment Results for ECEL 301, Fall 2004-05 (N=13, 38%)
5=expert, 4=good, 3=fair, 2=poor, 1=no experience

Rate your competency in this technical skill		Average	Standard Deviation
You have confidence in your ability to present your experimental work in a written laboratory report format.	Entering this course	1.75	1.22
	After taking this course	4.00	0.60

ECE 491 Senior Design Project I

ECE 491 is the first course in the three-quarter capstone sequence. Students spend the bulk of the fall quarter finding a design project, other students to work with, and a project advisor. Writing assignments for fall are a one-page pre-proposal, and a 10-page proposal (exclusive of appendices). More course details can be seen on the course web page[11].

Three WITs participated in Senior Design, with majors of Technical Communications, Biomedical Engineering and Physics. The Technical Communication major was extremely interested in the topic, and saw sitting in all the lectures as part of her professional development. While this effort was not required, or typical, it greatly enhanced communications between herself and her design groups.

The project pre-proposal and proposal were reviewed by the WITs prior to the final submission deadlines. Students got their work to the WITs as email or hard copy. Since scheduling meeting times for the WITs and design groups was difficult, email document exchange was encouraged. While one on one conferences did occur, in practice, most discussions on writing were done via email.
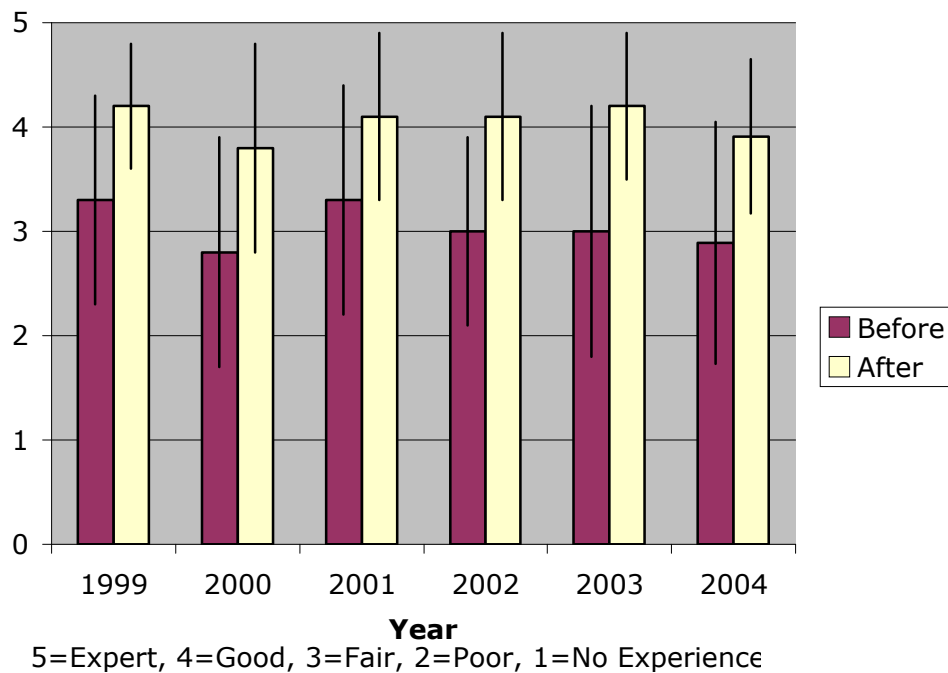
Figure 1. Student self-assessment in ECE 491 Senior Design Project I in response to the statement "Rate your competency in these technical skills - ability to write a formal proposal". Bars indicate the standard deviation.

The 2004 student self-assessment of proposal writing (Figure 1) does not show any statistical difference from other terms that did not use WITs. However, we found student generally receptive to the process of writing, feedback and editing. This was especially true for some of our non-native English speaking students.

Conclusions

Writing in the ECEL 301 course was an important learning experience for the instructor and the students. The self-assessment shows that the students are now much more confident in their technical writing ability, even if this assessment may be somewhat higher that their actual ability. Writing is a process, the first step of which is cognition, and the students will have more opportunities to improve their technical writing in future ECE courses using WITs. These writing intensive courses are spread over three academic years, with periods of coop employment between, and reinforce skill development and confidence at different stages of their engineering program.

Despite the fact that ECEL 301 was the sixth lab course in our curriculum, the students were not well prepared to write formal lab reports. This is understandable in retrospect since all previous labs were college-wide courses with about 700 students per course in the freshman year and 325 per course in the second year, where the coop system divides the cohort in half.

Using WITs and raising the number of writing assignments from 2 to 4 could improve the ECEL 301. The additional review and feedback could not be accomplished without WITs. We could also continue to raise the awareness of the importance of writing by communicating more in lecture and lab about writing topics. Other groups[1] have had writing assistants visit lab sections for the first part of a session. We could do this in our first two weeks, but after that time is too precious. Lab notebook reporting[1] should be considered in weeks where formal reports are not required to reduce the burden on students

In ECE 491 we need to improve the communications between the course instructor and the WITs perhaps by adding debriefing meetings after each assignment review. The WITS are students themselves, gaining new experience about the relationships between professors and students, and students and themselves, and it is incumbent on the instructor to help them adjust. Since interactions we mostly electronic, finding ways to facilitate this communication in the editing process will be important.

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[7] The public web site for ECEL 301 ECE Laboratory I is http://www.ece.drexel.edu/courses/ECE-L301. There is also a private WebCT site for software code submission and grade distribution.

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[11] The public web site for ECE 491 Senior Design I is http://www.ece.drexel.edu/SeniorDesign. There is also a private WebCT site for document submission, discussions and grade distribution.

Biographical Information

Kevin Scoles (Ph.D. Dartmouth College, 1982) is an Associate Professor and Assistant Department Head for Undergraduate Affairs in ECE. His interests involve semiconductors and devices, electronic circuits and

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Harriet Levin Millan is founding Director of the Drexel University Writing Program. Her first book of poems, *The Christmas Show*, (Beacon Press) was chosen by Eavan Boland for a Barnard New Women Poet's Prize. .She holds an MFA from the Iowa Writer's Workshop and her work appears in numerous literary journals, among them *Ploughshares, the Kenyon Review, The Iowa Review, and Antioch Review.* Her previous work on writing and engineering education, "Poetry and Engineering Education," appeared *in The Journal of Engineering Education.*