# Using Writing to Improve Retention: Rethinking the Purposes of Communications Assignments in the Freshman Year Experience Course for Engineers

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Abstract

From its inception in 1997, the University of South Carolina's freshman year experience for engineers (University 101-Engineering) has included report writing and presentation assignments to introduce students to technical communications principles. In 1999, engineering faculty collaborated with writing professionals in creating writing-related activities that would serve the broader goals of the course: helping students succeed and stay in engineering. These new listening, reading, writing and oral communications assignments introduce freshmen to the excitement of engineering and help them envision themselves as engineers. Many of the assignments focus on the relevance of science and math to the challenging and creative work of engineering.

This paper explains a sequence of communications assignments that encourage critical thinking and reflection about the intellectual and practical dimensions of engineering. The first group of assignments integrates practice in Internet searching, listening, note taking, responsive writing, reading and academic writing as students inquire into connections between engineers and scientists. The second group of assignments allows students to demonstrate their understanding of the relationship between science and engineering through inclusion of theory, design, and explanatory text in written and oral reports on a design project. The final exam, as earlier assignments, includes an essay focusing on the relationship between science and engineering.

Focusing on the theme of science and engineering throughout the course helps students appreciate the heavy emphasis on science and math in the engineering curriculum, as well as the importance of interdisciplinary collaboration in engineering projects. In addition, using a common theme for assignments throughout the semester aids in assessment of students' progress and evolving attitudes toward engineering as a course of study and as a profession. Preliminary evaluation of students' writing in the course suggests that the assignments effectively engaged some students in exploring the broad opportunities that engineering careers offer. The activities also provided students a venue for reflecting on their learning experiences and communicating their enthusiasm for specific engineering projects and disciplines.

## Background

In 1997, the University of South Carolina College of Engineering initiated University 101-Engineering (UN101-E), a version of USC's Freshman Year Experience course designed to help first-year engineering students adjust to college and to the demanding engineering curriculum. The UN101-E syllabus was packed with helpful topics: an introduction to engineering, study skills, computer tools, responsible behavior, a service-oriented team design project, and

communications skills. The ultimate goal of University 101-Engineering, of course, was to enhance the students' abilities to succeed and thereby address the problem of attrition, which had affected engineering education throughout the US in the past decade.

Following two years' experience, the USC College of Engineering revamped its UN101-E initiatives. In cooperation with University Housing, a freshman engineering living/learning community was created at Bates House, a dormitory close to the engineering college. Two sections of UN101-E were designated exclusively for the Bates House community. Students in these sections received laptops and communications software to facilitate team communications, and by design, faculty teaching these two sections created numerous opportunities for team interaction and for student-faculty interaction. A key component of the course was a new approach to the team design project. Previously, UN101-E featured a semester-long, service-oriented project in which the students designed and built storage sheds for a local Habitat for Humanity chapter. Many students found this project too daunting, especially those without any construction experience. Therefore, a shorter, less serious design project was implemented to create an inclusive experience that would be fun as well as instructive. Students worked in groups to design, evaluate, and race small edible cars.

Revised Syllabi and Assignments

Faculty teaching the living/learning sections modified their entire syllabi to emphasize active learning experiences that would make engineering more engaging for freshmen. In the light of recent research on attrition in engineering, activities that engage freshmen in exciting and interesting projects seem particularly important in improving retention. According to Seymour and Hewitt's 1997 study, *Talking About Leaving*, roughly half of the students who switch from engineering to another field do so because they lose interest in the engineering major in the first two years.[1] Forty-five percent cite the heavy workload and fast pace as their reason for leaving; forty-one percent say that ineffective teaching turned them off. And although nearly 25% of the students who left gave inadequate academic preparation as the main reason, all of the students in the Seymour and Hewitt study were bright, well-qualified students.

At the University of South Carolina, as at most research universities, the first two years of the engineering student's university experience involves taking a number of required science and mathematics courses. The students, eager to begin "real" engineering courses, have difficulty making connections between these foundational courses and their careers as engineers. To help students appreciate and experience these connections, the syllabi now incorporate many activities that emphasize the interface between science and engineering, as well as collaboration between scientists and engineers. The connections among science, math, and engineering become a common theme of the course in the hope that freshmen will begin to understand how all these seemingly disparate courses fit together and prepare engineers to innovate and solve problems creatively.

Communications Assignments

New writing and presentation assignments were developed for UN101-E to spark the students' interest in engineering and to heighten their understanding of the importance of science and math

in the profession. In collaboration with the director of the Professional Communications Center at the College of Engineering and Information Technology, the professor for one of the living/learning sections of UN101-E devised ways to make writing and speaking assignments part of the fun and excitement of the course. The communications activities also provide students a means to reflect on their learning and a method of inquiry into aspects of engineering that they find personally intriguing. (An overview of the assignments appears in Appendix A.)

*Assignment 1 -Listening, note-taking, reflection, responsive writing*. In the first set of assignments, students used a variety of media and activities to explore the connections between science and engineering. Using Internet search tools, students located and listened to a story featured on NPR's *Morning Edition*, entitled "Flies Hearing." This segment is an engaging and unusual story about an entymologist and a mechanical engineer whose collaborative research on the parasitic *Ormia Ochracea* fly led to improvements in hearing aid design. Students took notes as they listened to this rather vivid account of Ormia's directional hearing system that allows it to locate crickets to use as hosts for its offspring maggots. After hearing the sound of a maggot eating a cricket from inside out, students then heard the stories of the scientist and engineer who worked together to understand the fly's hearing apparatus and to put it to use to benefit hearing-impaired humans. Students wrote a short response paper on the relationship between science and engineering portrayed in the NPR segment and materials from their textbook and Internet sources.

*Assignment 2 - Essay based on listening, reading, discussion and responsive writing.* At the next class meeting, consultants from the Professional Communications Center led an in-class writing workshop to help students prepare to write an essay on the topic. This classroom session engaged students in discussing the NPR segment, other assigned readings on the *Ormia* research, and the overall theme of science and engineering. The writing consultants provided some general information on writing for the specified audience, including quotations and references in their texts, and conducting Internet and library searches. However, the main goal of the workshop was to involve students in thinking and talking about the relationships between science and engineering. To achieve this goal, the workshop included an exercise in which small groups of students collaborated in writing a thesis paragraph for the assigned essay and then reading their statements to the entire class. This simple exercise required students to begin inquiring into the connections between science and engineering as they sought ways to express that relationship. In this way, students started the intellectual inquiry that would continue throughout the course and would represent a major part of their final exam. As Appendix A shows, students were instructed to save their research materials to use in writing another essay on the topic as part of their final exam.

*Assignment 3 - Report, oral presentation, and feedback on edible car design project.* Later in the semester, students demonstrated their understanding of the relationship between science and engineering via a team design project. (Design project assignments appear in Appendix B.) This design project included a number of reading and writing exercises, as well as final written and oral reports in which students described the engineering design process they followed. First, students read about and discussed the engineering design process in class. Then they applied each step of the design process to the problem at hand, and turned in group assignments after completing each step. These assignments were then evaluated by the professor, and returned to

the groups to provide needed feedback. After teams reached the step in which alternative designs were evaluated, they fabricated their best designs and prepared to race in competition. The cars were raced down a 3:1 slope in competition against cars fabricated by another UN101-E section and then recycled (i. e., eaten) by team members. The race outcomes were specifically not graded to make the exercise more fun for the students.

Instead, students were evaluated based on their written and oral reports detailing the groups' efforts to design edible cars that meet the prescribed criteria. Early in the design project, consultants from the Professional Communications Center visited the class again, this time to introduce students to the rudiments of technical reporting. As before, the consultants used a workshop format to engage students in discussing specific approaches they could use to fulfill the report and presentation assignments. After a brief overview of purposes, audiences, and structures of technical report, the consultants asked each of the student teams to draft an abstract for their written report. Each of the teams received guidance from the consultants in composing the abstract. Later, teams read their abstracts aloud, allowing the whole class to raise questions and give feedback. The Professional Communications Center staff concluded the workshop with a model oral presentation and a discussion of the similarity between writing an abstract and outlining a PowerPoint presentation.

In addition to their formal reports on the design project, students were asked to provide feedback on the experience using a web-based survey including the following questions:

1) Please rank the level of participation of the member of your group (including yourself) from 1=low involvement to 5=high involvement.
2) Rate the ability of your team members to work with others: 1=doesn't work well with others to 5=works very well with others.
3) Discuss any difficulties your group had working together.
4) Discuss the successful aspects of your team interactions.
5) How would you improve the competition for next year?

This assessment tool not only provides feedback to the instructor about students' perception of their experience in the design project, but also, and perhaps even more important, the survey asks students to write about their experience. In the process of writing, students must also reflect on what they have learned. Students were surprisingly forthcoming and detailed in their answers to this survey, suggesting that the web is an excellent means for eliciting good feedback from students. Moreover, responding to the survey questions is an authentic communicative act; the audience is interested in the writing, and the student writers are the authorities on the topic.

The students' answers to the survey reveal much about the quality of communications within the teams, although the topic of communications was not specifically raised in the questionnaire. Student replies to this survey indicated that, with few exceptions, they felt that team members had participated equally and that they worked well together. Difficulties encountered included getting everyone together for meetings outside of class, despite the fact that they all lived in the same building. In response to the fourth question regarding successful aspects of the team interactions, one student wrote: "Each member has his/her own strengths which he/she utilized at some point in the design process. We learned leadership, communication, and problem solving

skills. We got to know each other during the process." Another student wrote this response: "Good communication … between each other (e-mailing final product to each other before final copy [was] sent, delegation of work, acceptance of ideas, constructive criticism, etc.)." Student replies to the fifth question indicated that they enjoyed participation in the design project, but many suggested that more specific design criteria would have been helpful. None of the students stated that they felt overwhelmed or uninterested in the project.

*Assignment 4 - Final exam.* The final exam, as earlier assignments, included an essay focusing on the relationship between science and engineering. This final writing assignment provided another opportunity to assess students' understanding of connections between science and engineering and to determine if the class exercises had nurtured their interest in engineering. Students were asked to write an essay to a high school student or incoming freshman describing the relationship between science and engineering, by drawing from their writing and design activities in class, as well as their personal insights and external sources. Many of the students' final essays included important observations about their experiences in class and their growth as engineering students.

The students' submissions revealed that they had fully comprehended the unique and important linkages between science and engineering, by drawing on examples from the listening exercise, supplementary reading assignments, and design project. One student notice noticed the importance of science in the class design project, stating,

> "It was obvious who in the group had had a strong background in the field of physics. I, for example, who had never taken a physics class…found myself at a disadvantage because I could only speculate how changes in the mass of the car would affect the performance of the car in the race."

Another commented,

> "The design of the edible car may not have the same impact on society as a hearing aid or other developments due to science and engineering, but it illustrates the necessity of collaboration for productivity."

Yet another student wrote,

> "Our design project was plenty of work but also a lot of fun. We learned many things about working in groups. The project made me see how the design process works to help engineers through a project."

There were also many cases in which the students had searched out examples of the importance of science to engineering that demonstrated their interest in engineering. One student discussed the role of science and engineering in the creation of the Hubble telescope, while another wrote about an advance in biomedical engineering that intrigued her:

> "[A] graduate student of Oxford University is working on the development of a computerized system which would aid in the birthing process by monitoring the health of

the unborn fetus. Because…this student has majored in both medical and electrical engineering, it has enabled her to create a computerized system which could be used to detect any stress…by measuring the heart rate."

Writing as Inquiry: Personal Interests and Professional Identity

Students in this UN101-E section not only learned something about engineering and science, but they also started on their individual paths of inquiry into areas that fascinated them. They began to develop an understanding of the engineering community they were entering and of their roles within it. In part, we believe, this growth was facilitated by the various writing assignments. Some of these assignments resembled the formal reporting tasks of engineering, but others called for reflection, inquiry, and even personal opinion.

The communications assignments in this UN101-E section build on emerging concepts of writing in the disciplines. In the past few decades, professional disciplines, such as engineering, have incorporated various writing in the disciplines strategies and concepts, primarily as a way to introduce students to the discourse conventions of the profession. However, as Kirtsch et.al., observe, the writing-in-the-disciplines movement contains two, sometimes opposing, pedagogical strains: writing-to-learn vs. learning-to-write-in-the-disciplines.[2] Writing-to-learn involves informal writing as a tool for active learning; the second instructs students in understanding and creating the formal genres of their chosen field. Kirtsch and her colleagues, arguing that there are "living interconnections between active learning and social communication; between individual experience and the social act," propose a merger of the two, into a "rhetoric of inquiry." Such an approach has special application in freshman engineering courses that are designed to engage students in exploring the field of engineering and finding personally rewarding activities within it. Giving students numerous opportunities to write about their experiences, to share their findings with teammates and teachers, and to reflect on their own progress is an invaluable means of helping students progress. In contrast, focusing exclusively on the fundamentals of technical writing in the freshman year is probably not the best way to help students discover the excitement of engineering

As Hillocks writes, "Writing is at the heart of education when it is connected to inquiry and when inquiry is in the hands of the students. . . .Writing is a chief means of extending, shaping and rethinking that inquiry and carrying on the dialectical processes involved.[3] But equally important, writing can play an enormous role in the intellectual and personal growth of the emerging professional. "With each writing," Hillocks observes, " we review our knowledge. In doing so, we have an opportunity to rethink, realign, and reintegrate it, a process that, in effect, changes who we are."

Assessment

Evaluating the success of UN101-E required seeking evidence that students found excitement, interest, and fun in at least some of the classwork and activities. Students' essays, informal writing, and web-based assessment provide that evidence. Additional assessment is presently being performed by the director of assessment for the College of Engineering and Information Technology. The formal assessment, consisting of student interviews, final grades, and course

evaluations will provide insight into the overall success of the course. The development of students' writing abilities will also be assessed by comparing strengths of their first and final essays. Using the same topic and assessment criteria for communications assignments at the beginning and end of the course should prove valuable in evaluating students' progress and their evolving attitudes toward engineering as a profession.

Conclusion

Without question, writing and communications assignments should be an integral part of the freshman year experience for new engineering students. Industry and accrediting bodies are emphatic in stating the need for engineers to communicate effectively. At the same time, many engineering majors are emphatic in expressing their distaste for writing, an antipathy most developed in high school. Therefore, writing activities in the freshman year engineering course support course objectives and the needs of entering students. Those needs include opportunities for intellectual growth and inquiry, for dialogue with professors and classmates, and for beginning to learn the ways that engineers communicate. The structure and design of writing assignments in the freshman course should address these multiple ends.

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1. Seymour, E. & Hewitt, N.M. *Talking About Leaving: Why Undergraduates Leave the Sciences.* Boulder, Colo: Westview Press (1997)
2 . Kirscht, J., Levine, R. & Reiff, J. Evolving Paradigms: WAC and the Rhetoric of Inquiry. *College Composition and Communication*. 45.3. (Oct. 1994).
3. Hillocks, G., Jr. *Teaching Writing as Reflective Practice*. New York: Teachers College Press (1995)

## Appendix A - UN101-E Communications Assignments

### Assignment 1. Listening, note taking, responsive writing.

***Instructions to students:***
Listen to a report on National Public Radio that discusses the work of scientists and engineers in studying a fly's hearing apparatus.

Visit the following web site: http://search.npr.org/cf/cmn/cmnpd01fm.cfm?PrgDate=07/12/1999&PrgID=3

Take notes as you listen. Using your notes, write a few sentences describing the relationship between basic science and engineering that the radio report brings out. Bring this responsive writing assignment to the next class meeting.

### Assignment 2. Essay based on listening, reading, and responsive writing.

***Instructions to students:***

Read the class handouts and write a 1 to 2 page essay that describes the relationships between the work of scientists and engineers. Refer to the articles you've read and the radio clip that you listened to last week.

Your audience for the essay is high school students or college freshmen who are interested in careers that involve either basic or applied science. Your purpose is to help your readers make informed choices about their college majors.

Your essay will be assessed on the following criteria:

Appropriateness for the audience and purpose
Inclusion of references to and examples from the assigned reading and radio clip
Clear comparison and contrasts between science and engineering
Clear organization, coherent paragraphs, and variety in sentence patterns
Correct usage, grammar, and mechanics
(The College of Engineering and Information Technology uses assessment in courses in all departments to improve the quality of our educational programs.)

Save all of your materials for this assignment. Part of the final exam in the course will be an essay on science and engineering.

**Assignment 3. Report and oral presentation on edible car.**

***Instructions to students:***

Write a report of your design activities including the following items: abstract; table of contents, table of illustrations, introduction, design overview, theory, materials and methods, results, conclusion. Illustrations include design drawings, calculations, materials costs, and test data.

Prepare an oral presentation. This is to be a team presentation. A maximum of six transparencies or PowerPoint slides may be used. Each team member must participate.

**Assignment 4. Final Exam - Essay comparing science and engineering.**

This essay, written for the same audience and purpose as Assignment 2 earlier this semester, and should be based on your reading, experience with the design project, and class discussions throughout the semester. The essay will be assessed according to the same criteria used for Assignment 2, except that the final essay should include personal insights as well as external sources.

**Appendix B – Design Project Assignments** [1]

**Design Project Statement - The Incredible Edible Car Design Project**

Design a car with wheels to travel down an inclined plane. The incline will be 3:1 and 1 m long. The vehicle must not be over 4 inches wide, 4 inches tall, and one foot long. An additional constraint is that the entire car must be edible and must contain at least six different food items. Judging will be based on appearance, speed, how far the car travels after leaving the end of the track - if it survives in one piece, and the time it takes the team to eat the car. Races will be run against cars designed and fabricated in another UN101-E class.

Requirements for Report and Oral Presentation on Edible Car

Report: Include abstract, table of contents, table of illustrations, introduction, design overview, theory, materials and methods, results, conclusion (illustrations – design drawings, calculations, material costs, test data).

Oral Presentation: This will be a team presentation. Groups may present a maximum of 6 transparencies or PowerPoint slides. Each team member must participate in this 10-minute presentation.

**Design Project Assignment 1**[1]

Send the following information as an attachment via e-mail to the professor: One assignment per team.

- List the team members (first and last names). List the name of the democratically elected team leader.
- Define briefly the problem to be solved in a detailed paragraph for a maximum of one page.
- Begin your search stage in the design process.
- Cite at least four resources, in proper form, which you have used in your search. One of these must be a patent or journal (serial) publication.
- Need help in formatting your reference citations? Use one of the following:
  - *AIP Style Manual* (American Institute of Physics)
  - *A Manual for Writers*, by K. Turabian, revised by Grossman and Bennett.
  - *Chicago Manual of Style*, 14th edition, 1993.
- Remember that the goal of this exercise is to gather information for use in the next phases of the design process.

**Design Project Assignment 2**

Submit the following information to the professor via e-mail. One submission per team.

- Briefly state <u>your</u> design constraints.
- Briefly list <u>your</u> design criteria and weight them accordingly.
- Summarize a few of the ideas that came form your brainstorming session(s).
- Continue your searching for information, and think about ease of manufacture along the way...

**Design Project Assignment 3**

Now that your team has identified design constraints and developed a weighted list of design criteria, it is time to have a little fun! Each team member is to fabricate an edible car to bring to a team meeting. Teams will analyze the alternative designs according to their own design criteria. Based on these results, each team will determine the final design to be pursued.

The written portion of this assignment is as follows. Prepare a table listing the design criteria and weights, and show how the various design alternatives performed. Select the most favorable design. Discuss what the team learned in this exercise, and how information gained from analyzing the alternatives will help the team in the final design and fabrication process.

Example Table:

| Design Criteria and Weighting Scheme | | Design 1 | Design 2 | Design 3 | Design 4 |
|---|---|---|---|---|---|
| 1. Cost<br>2.<br>3.<br>4.<br>5.<br>6.<br>7. | 10% | 6 | 5 | 9 | 1 |
| Total | 100% | | | | |

[1] The design project and design project assignments 1 and 2 were adapted from those created by Dr. Suzanne Rohde, Associate Professor of Mechanical Engineering, University of Nebraska-Lincoln, for her Introduction to Mechanical Engineering course (MECH 100). The authors gratefully acknowledge Dr. Rohde's contributions to the success of the design project phase of the course.

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