Team Teaching: A Freshman Engineering Rhetoric and Laboratory

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Abstract

Team teaching usually involves the back-and-forth trading of lecturing between two instructors. The present example illustrates a looser side-by-side collaboration consisting of a first year rhetoric, based upon readings, poetry, and videos in technology, literature and history, and a “hands-on” laboratory centered around consumer electronics. The effect achieved is a bridging of the “two cultures” by viewing technology through alternating sets of glasses.

Introduction

Directors of university engineering curricula are besieged by ever noisier clamour for more and earlier “hands-on” experience, and for more exposure to, and practice in, reading and writing “across the curriculum” in course-centered formats. The freshman year is a logical target for new course innovation, except for the obvious problem that the first engineering year often has few, if any, elective spaces for new, widely available experiments in engineering education. Therefore, new first year courses are expected to pattern themselves after existing requirements, in order to satisfy the argument of the type “please accept new course X in lieu of current Y”.

A new example from our NCSU College of Engineering is an integrated version of mathematics, physics, and chemistry, known as IMPEC and described in the preceding paper (l); here the challenge is largely curricular integration to give physics or chemistry a “just-in-time” mathematics component, all spiced with design examples from
engineering, and reformatted to prescribe learning in teams. The curricular space availability is certain in this new six-unit course which neatly covers each semester the materials in the previous pair of three-unit courses (either physics or chemistry, plus mathematics).

We describe here a second NCSU freshman engineering course, cast in a less familiar format, achieved through integrating a "hands-on" laboratory with a composition and discussion class based on readings about technology. A one semester freshman composition requirement is the replacement equivalent sought for this new venture, which is a joint effort between an engineering professor, David Ollis and a former NCSU English instructor and current Co-Director of our College of Engineering Writing Assistance Program, Ann Brown.

First we review the motivations for such course integration, in order to provide purposes far more convincing than a mere scheduling convenience. In later sections, we describe the course content, the fall '95 pilot offering, and a brief student and instructor evaluation.

The Intellectual Challenge: Integrating Humanities and Technology

Many arguments can be made for combining science and technology with history, art, and literature. Two motivations, pertinent to our rhetoric and laboratory integration, are offered by the editors of two technical anthologies:

In their World of Science: An Anthology for Writers (2), Gladys Leithauser and Marilynn Bell argue that current technical education shortchanges the student of firsthand contact with the scientists and technology writers they wish to become. Such direct contact these editors achieve through readings and writing from their anthology, which is based in science:

One organizing principle of this collection is that student writers often do better work when their readings reflect their special interests. Yet anthologies of such readings are rare for students in the natural sciences.(2)

The second reason arises from our desire to minimize the "two cultures" mentality, so evident in both engineering and humanities.
curricula. In Writing About Science(3), Elizabeth C. Bowen (writer) and Beverly Schneller (Professor of English) challenge the notion that “In most people’s minds, and certainly in many humanists’, scientists are notoriously bad writers.” To meet this challenge, these editors provide the obvious antidote: good examples.

By such introduction, these latter writers argue that their anthology could play some role in challenging the cultural stereotype (described above) and perhaps in lessening whatever truth it has. We know that science students are served by traditional freshman English anthologies and that writing can be taught equally well when the subjects of composition are scientific ones. Our aim is to present models of good scientific writing and, through the study questions, to challenge both student and teacher to consider them as writing, not solely for their intellectual content but for their rhetoric and style.

If these two, italicized assertions are true, then nascent undergraduate engineers should be excited early on by reading and writing about the histories and heroes and, yes, even villains, of engineering and technology. The corresponding literature should also teach and inspire good writing, i.e. good communication; it should therefore lead students to the conclusion that effective engineering involves far more than design and manufacturing.

Course Content

Reading and Discussion

Our fall ’95 readings surveyed the role of the engineer from the Classical Age to the Steam Age to the Modern Age of Total Quality Management. The engineer was studied as a hero, as a character in science fiction, and as a villain of the anti-technology movement. To complete the survey, the course included women in engineering and contemporary challenges in engineering ethics. Throughout the survey, two question provided continuity for discussion: How did each society regard the engineer? What forces produced this opinion?
Assigned topics for discussion included Hephaestus, the mythical metallurgical engineer in Homer’s The Iiad and John, Washington, and Emily Roebling, the heroic engineers of the Brooklyn Bridge. Emily Roebling also introduced the attitudes challenging the woman engineer. Contrasting heroic and villainous portraits of engineers were studied with the science fiction of Jules Verne and Ursula LeGuin, respectively. Poetry by Emily Dickinson, Walt Whitman, and Carl Sandburg celebrated engineering achievements at their most heroic, while the verse of William Wordsworth and Henry Reed portrayed the destructiveness of technology. John Hersey’s A Single Pebble presented the paradox of a civil engineer attempting to build a modern, lifesaving dam in ancient-culture China. Finally, the anti-technology movement and engineering ethics were discussed in response to Vance Packard’s The Wastemakers. Additional engineering ethics discussions responded to the impact of the TVA on a northwestern North Carolina county, and to a 1995 newspaper series on the state’s expanding large-scale hog industry. Several readings were provided by engineer-writer Samuel Florman, the many roles of bridges were displayed in Henry Petroski’s essay “Imagine,” and the semester ended with Richard Meehan’s description of engineering’s psychological rewards in “Snowbound on the Rio Pangal.”

The selection criteria for these varied readings were only two: All had to concern engineering or technology, and all had to be well written, thus providing positive models for the students’ themes. (We leave to others to discern why these civil engineers write so well!)

Writing Assignments

Students developed writing skills by completing daily journals, by analyzing written instructions, and by writing formal themes. Their journals included comments on class discussions, new ideas about technology or engineering, and design problems observed in daily life. Journal entries were collected three times, were read, and for the most part, returned without comment. Although several students completed their journals begrudgingly, most agreed that the writing process helped them to articulate ideas better. Ironically, the student who objected most strenuously to journal writing responded to one of Ann’s rare journal comments by turning one of his entries into an A theme.
In an additional study of writing, students provided and analyzed samples of commercial, written instructions. These instructions, for a variety of subjects from furniture assembly to software use, were analyzed to determine why good ones succeeded and poor ones failed. By semester's end, the class had produced four guidelines for writing successful instructions, and voted to pass these on to succeeding classes to complete.

Students wrote and revised six formal themes during the semester. Theme topics grew in complexity, from "Describe a person or event that influenced you to pursue an engineering education" to "Critique and edit one of the lab manuals you have used this semester". Additional topics included comparison/contrast and process analysis papers and an analysis of a current advertisement, article, or editorial related to engineering. One theme, a mini-research paper, challenged students to select an engineer whom they considered a hero(ine) in his/her field and to defend this status based upon the engineer's achievements. This assignment differed from the norm not only by requiring outside research, but also by assignment of report responsibility to a lab team rather than the individual student. Some students were initially delighted because they supposed that having a co-author would mean halving the work; however, they soon learned the challenges of collaborative research and reporting. Usually, these team results required more revision than single theme assignments, but the final outcomes were quite impressive. Overall, the students' writing skills developed during the semester in direct proportion to the number of revisions submitted.

**Alternative Media**

Class discussions were also stimulated by paintings, lithographs, and videotapes. Currier and Ives provided romantic and allegorical interpretations of the steam locomotive. A variety of paintings demonstrated both positive and negative views of engineering technology. Ken Burns' video "biography," *The Brooklyn Bridge*, provided historic and aesthetic highlights of this landmark in civil engineering. The 1920's silent movie *Metropolis* gave a unique perspective on a futuristic world.
and helped introduce engineering ethics and the anti-technology movement. An end-of-semester "OPEN HOUSE" student presentation to English and Engineering faculty was accompanied by large, color posters of the often attractive covers (and clips of reviews) from books excerpted for class use.

**Laboratory**

The course was originally constituted in summer '93 only as a "hands-on" laboratory, primarily of consumer electronics devices, to which a small library of repair manuals and histories of technology and science was added. In this first version, students worked in teams of two or three, exploring each of five or six light-based devices such as a photocopier, bar code scanner, videocamera and VCR, compact disc (CD) player, and an optical fiber communication kit. These products were chosen as examples of technologies with growing futures, and hence the technologies of the students' professional generation. In retrospect, these are largely technologies of the Age of Information.

At the close of the original, laboratory-only course pilots of '93 and '94, student evaluations indicated that the most exciting aspects of this laboratory course were (1) collaborating rather than competing, (2) having the freedom to tinker and take things apart, and (3) teaching to and learning from each other. These original course versions were summer stock, with 40 hour per week uninterrupted efforts. The continual and intense student collaboration on common topics of interest worked well to develop very positive interactions in nearly all groups each time.

In the present integrated lab and rhetoric, each team played through the successive roles of user, assembler, and engineer in different lab periods, as before. The user demonstrated comprehension of the product user manual and competence in executing the basic functions of the device. The assembler role allowed extensive "taking apart" to see the innards clearly and discern how at least the mechanical and optical components worked (In the interest of safety, no live electronics were allowed during disassembly). The use of simple formulas to characterize quantitatively the device performance provided the introductory role of the engineer as the bilingual analyst who can think and describe the same phenomena verbally or quantitatively. Examples of variables calculated
were videocamera lens focal length, photocopier light intensity, device power consumption, battery lifetime, CD information density, optical resolution, fiber optic internal reflection losses, etc. Because first semester university students were involved, no formal calculus was required, although a few students demonstrated prior calculus familiarity when the time came to invent, rather than simply solve, problems.

The commencement of each lab cycle with a new device included the reading of a 30-50 page draft lab-manual chapter, and the viewing of a short video, both of which were created previously by a graduate engineering student in David's photochemical engineering course.

The activity closing each cycle was a team oral presentation, jointly graded by both instructors. Basic diagrams, graphs, and tables (ten to fifteen) were provided in advance as transparencies, and students invented new versions as desired. In these presentations to the other four or five teams, the desire to inform and impress their peers proved to be a powerful motivator for team success.

**Course Integration: the Continuing Challenge**

With this first course offering in the new integrated format, we attained more of two offerings in parallel than a true integration. This early result arose partly from the need for the instructors to become acquainted with each others' academic instruction styles and materials. On our next round, we will extend the reading and writing to include the ages of electrification and electronics, and the emerging technical importance of light and the Age of Information.

A certain amount of looseness in discussion-lab integration is probably desirable and unavoidable. The lab devices available will vary over time; engines and structures could equally well have been chosen for demonstrations in lieu of light-driven devices. The humanities portion could remain an historical survey, or be recast to concentrate on any particular time, e.g., readings and discussion about the Age of Steam and the Industrial Revolution would match well with an engines and structures lab.

A less visible, but important, dimension of the course integration is the allowance it provides for cross-cultural collaboration between faculties in the humanities and in engineering. This opportunity alone is worth the admission price for assembling a new course in academia.
Evaluation

Two questions provide a proper test of any course, particularly a pilot version: Does it satisfy a demonstrable need? Do the students believe they benefitted from it? We conclude the answer to both questions was “Yes!”. Most students indicated that the course gave them a practical and accessible introduction to engineering, and that, given the opportunity, they would take the course again. An additional benefit arose from the modest section size (20 maximum), which helped new students acclimate to the impersonal setting of a large university.

Perhaps the greatest advantage for this integrated course lies in its potential for greater student collaboration. These students found that the “learn by doing” and “teaching each other” approaches produced more learning than a typical, introductory freshmen lecture course. While students collaborated in teams for the lab, this activity was used only occasionally in the humanities portion of the class (e.g., for a team research paper). On these occasions, student teams collaborated on reading assignments; the results indicated firmer comprehension of the assignments and provided more vigorous class discussions. The potential for further joint activity is large: Teams could collaborate on units of study instead of individual assignments, and could integrate discussion and writing assignments with laboratory exercises, and might even lead occasional discussions on their team’s topics.

The potential for increased quality of learning from these small group activities should also provide an answer to the problem of meeting initially less qualified students “at their own level”. Rather than having complicated course material boiled down to make it more comprehensible to the least prepared students, collaboration in small, informal groups can stimulate these same students to bring themselves up to the desired level of achievement. Further, as future professional engineers, all students need to develop the “soft skills” required to integrate their ideas and personalities into productive, smoothly functioning teams.

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References


