

Teaching Technical Communications in an Introductory Design Course through Interventions from the University's Writing Center

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Abstract

This paper describes the continuing and evolving relationship between the Writing in the Discipline Program in the University of Houston Writing Center and the Cullen College of Engineering. This specific project is an intervention into a sophomore design course in mechanical engineering that took place for the first time in the fall 2004. The paper will describe the development of the course-specific workshops and the establishment of a "draft review" process utilizing a peer Writing Consultant. Student surveys were used to assess the effectiveness of the new process. The student response was positive, but a few students resisted the implementation of a significant writing component into a "design" class. Only minor modifications were implemented as the intervention continues for this spring semester.

Introduction

Since 1980 the BSME degree at the University of Houston (UH) has required a sophomore design class. Initially, the course covered primarily the design process and design methodology. A semester-long design, fabricate and test team-project was the major component of the course. A team written report was required. The course underwent a major revision in 1991 when the faculty member who initiated and taught the course left the University. However, the course has been taught, each fall and spring semester to between 35 and 65 students since 1980, and the course has continued to evolve. The current course content includes: engineering in the global perspective, the design process, shop practice, introduction to manufacturing, engineering communications, specifications, personality and group issues, codes and standards, intellectual property, engineering ethics, and introduction to engineering economy.

The course is usually the first engineering course taken by a mechanical engineering student. Therefore, part of the course objectives is to introduce students to, and build their confidence in, problem-solving. During a typical semester, one major team project and two or three minor projects (individual or team) are assigned. While the intent, extent, and format of the minor projects change each semester, the format, structure and the evaluation process for the major projects (which change each semester) have evolved to a more or less steady state and remains the single most significant part of the course counting for as much as 50% of the course grade.

The major project is presented to the class in the second week and continues throughout the semester. Among the deliverables are: a working device which satisfies a set of constraints and performs satisfactorily, written progress reports, team meetings with the instructor, initial testing (proof of concept), final testing in which success in approaching specified goals is measured, a final written report, a final oral presentation and a device for evaluation. The team performance on all of these “requirements” contribute to the final grade for the project and remove much of the “pressure” for a device to “perform” at the final testing, i.e., the execution of the design process is viewed as an important part of the evaluation of the project.

The three credit-hour course is organized as a two-hour lecture (for the entire class) one day each week and three-hour “work sessions” or studios limited to about 24 students each week. On average about 45 students enroll each semester, so there are usually two studios. The studios are used for various purposes including formal student presentations, prototype testing, shop tours, scheduled instructor meetings with individual teams, “work-on-project-time,” and, for the first time last fall, the communications workshops. On the first day of class, the students are told that in their studio that week they will be expected to make a three- to five-minute oral presentation. The topic is open, but they are told that it is preferred that they talk about themselves and most do. This experience serves two primary purposes: first, few of the students know anyone else in the class so these presentations allow the students to introduce themselves (very helpful since design teams will soon be formed) and second, several oral presentations are required during the semester and the more these are practiced the better.

The first lecture discusses the relationships between “engineering” and “science” and then between “engineering” and “design”. The design process is introduced. Machine tools, shop practice and manufacturing processes are reviewed in the lecture in the second week. The major project also begins with the distribution of the project description (usually a ten to twelve page document). A brief overview of the project is also given. Each studio is divided into four groups (about 6 students per group) and scheduled for a machine shop “experience”. For the next two weeks each group attends a ninety-minute session in the Department Machine Shop in which they will participate (with the Department machinist) in the production of a simple metal part utilizing an engine lathe, a vertical mill, a vertical and a horizontal band saw, a drill press, grinders, and a tapping set. The operations of various other hand tools (e.g., calipers, micrometers, broaching set, etc.) and many of the accessories for the machine tools (e.g., various three and four jaw chucks, mills, bits, borers, taps, etc.) are also demonstrated. A handout is provided which describes the operations of all the standard shop tools. Shop drawings are discussed from the machinist’s perspective. There is also a demonstration of an NC machine. Additional details on the content and operation of the class can be found in Reference 1. The rest of this paper will focus of the evolution of the technical communications content of the course.

As noted above for the major team project, a formal written Final Report has been required since the initiation of the course. For about the past ten years two formal, written progress reports are also required. Each team makes a twenty-minute, PowerPoint presentation to present their “case” and to sell their device at the end of the semester. In addition to the team reports at least one significant individual writing assignment and several smaller writing assignments are given. Individual presentations are also occasionally assigned. While instructor feedback is provided

on the written and oral assignments, it had become apparent that the students could benefit from additional and perhaps earlier help with their technical communications.

For many years the undergraduate core for the University of Houston (and elsewhere) had required 12 hours of English. However, in 1998 the Coordinating Board for Higher Education in Texas mandated a “transferable core” among all public colleges and universities in the state and essentially forced all colleges to reduce their core curriculum to the Board’s “minimum.” (Otherwise, if a college requiring a 40-hour core, accepts a transfer student (who has completed the core at his former school) from a college requiring only a 30-hour core, the student must be given credit for the ten hours difference and is not required to complete the core at his “new” school. That is, the core is not to be transferred course-by-course, but only as a “core”.) As a result, only six hours of freshman English is currently required for our BSME graduates. A previous paper² describes the development and the results of a collaboration between the University of Houston Writing Center and the Cullen College of Engineering in improving the instruction in technical communications in the College’s Multidisciplinary Capstone design course. This paper describes a similar intervention in the sophomore design course in the Department of Mechanical Engineering.

The University and the Students

The University of Houston was founded in 1927 and has recently been designated as a “minority serving” institution by the federal government. It has an enrollment of just over 35,000, but provides on-campus housing for only about 5000. The Cullen College of Engineering enrolls about 2500 students, including about 1700 undergraduates. The Department of Mechanical Engineering has about 350 undergraduates and grants about 50 BSME degrees a year.

Teaching communications, especially technical communications, is a particularly difficult issue at the University of Houston for two reasons: the large number of foreign born, non-native speakers and the diversity of the students’ backgrounds, especially early college experiences. For example, Table 1 provides some information regarding the students enrolled in the sophomore design class in the fall 2004 (total enrollment of 58). The data in Table 1 is typical for the undergraduate ME students except that the male-female ratio is more like 6 to 1 for all the ME undergraduates. The point is that there is little control over communications (English) education for the students entering the course. Most take their English at community colleges (even those enrolled at UH), and their communications abilities range from “barely adequate to survive” in an English speaking society to a highly professional level.

The University of Houston Writing Center

US News & World Report has identified UH as the nation’s most culturally diverse large research university³. In a university thus challenged by a linguistically and academically diverse student body, ensuring writing competency is a daunting but crucial task. It was this high-need, limited-resource environment that led the young Writing Center – established by the English Department in Fall 2000 to provide assistance to students in core composition classes – to

Foreign born	34%
Non-native English speaker	28%
Transfer student with >30 hrs	67%
Degrees earned:	
MS or MFA	3
BS or BA	6
Associates	7
Average hours enrolled	13.4
Average hours of work a week	16.8
Full time employed	11
Ethnicity:	
Caucasian	46%
Hispanic	25%
Asian	16%
African American	5%
Middle Eastern	5%
Other	2%
Gender:	
Male	90%
Female	10%

Table 1: Data on Students Enrolled in Sophomore Design for Fall 2004 (58 total)

develop an instructional model based on “Writing Consultants,” or peer writing coaches. At UH, Writing Consultants are full-time students, primarily undergraduate, who have demonstrated high aptitude in writing and leadership skills. Fewer than half of Writing Consultants major in English or Creative Writing; more than 55 % are Honors College students. In statistically significant use, this model has proved successful at UH, and appears promising for larger-scale writing instruction at UH and on other limited-resource campuses.

Through small group meetings and tutorials, Writing Consultants provide sustained, individualized writing instruction unencumbered by disciplinary or grading duties that could compromise the consulting relationship or the student’s learning process. The Writing Center began training Writing Consultants as front-line instructors when revamping an ailing Developmental Writing Program in January 2001. After Writing Center intervention, the pass rate soared from 65% to 90%, and has since maintained that level. The increased pass rate was validated – and the Writing Consultant model was proven effective – by a year-long independent study demonstrating that in subsequent writing courses, Developmental Writing students deemed “underprepared” upon university admission achieved final grades at or above the mean final grade of their “prepared” peers.⁴ This model has been adapted for English as a Second Language (ESL) composition courses, with similar results.

The Writing Center provides the University of Houston community with resources for discipline-specific writing practice and instruction through the Writing in the Disciplines (WID) Program.

Since its inception in fall of 2002, the WID Program has provided writing support to various colleges and departments across the University, including the Cullen College of Engineering, Bauer School of Business, Graduate School of Social Work, Law Center, College of Liberal Arts and Social Sciences, and College of Technology.

The Writing Center's collaboration with the Cullen College of Engineering was one of the first that developed in the WID Program. Since then, the Writing Center has worked with faculty from the Electrical, Industrial, and Mechanical Engineering Departments. In the fall semester of 2004, the Writing Center maintained 13 WID projects, including the support offered to MECE 2361, the sophomore design course that is the subject of this paper. The Writing Center offered MECE 2361 students team and individual consultations with a peer Writing Consultant as well as five interactive, 90-minute technical communications workshops designed to prepare them for specific course assignments, familiarize them with the standards of writing within their field, and provide a forum in which they could practice and improve their technical communication skills.

Interactive Workshops

The workshops began with a 60-minute PowerPoint lecture on the main workshop topic, followed by approximately 30 minutes of group and individual discussion of handouts and examples provided by the workshop instructor. The workshops covered the following topics: Progress Reports; Abstracts, Introductions, and Context in Engineering Reports; Results, Discussion, and Recommendations Sections of Technical Reports; Technical Reports; and Presentations.

The first workshops were report-centered (Progress and Technical Reports) and were designed to familiarize students with the purpose, audience, and traditional presentation strategies of each type of report. Prior to instruction about the specific elements of each type of report, students were informed about the purpose behind each report – that the reports take place within a different context (namely a different stage in the design process and for a specific audience) and that this affects the structure and content of the report. The workshops presented report writing as linked to the design process, both aiding in the planning and execution of the design and essential to its final presentation to the project administrator or, in their case, the course professor.

The previous workshops having addressed the purpose and audience of each type of report, the section-specific workshops (Abstracts, Introductions, and Context in Engineering Reports and Results, Discussion, and Recommendations Sections of Technical Reports) were designed to familiarize students with the most important sections of each type of report and provide strategies for writing these sections. The workshops specified that each section of a report has a specific purpose and provides the reader with particular information for an explicit purpose within the report as a whole. The workshops also presented effective methods to establish context in abstracts and engineering reports. Special attention was paid to developing writing strategies for report-centered and extended abstracts since they are extremely important to technical writing and often require a unique approach in order to prepare them effectively.

For the Presentations workshop, students were exposed to general strategies for effective oral presentations, guidelines for appropriate use of PowerPoint technology in a presentation, and typical writing issues associated with slide composition and the presentation of graphical data. In addition to instruction on the main topics, the workshops targeted essential information, skills, or “tips” related to technical writing and communication in general. These elements were presented and practiced in multiple ways throughout the semester, during both the workshops and the meetings with the course-assigned writing consultant, where students were able to practice and discussed what they had learned.

Among the targeted concepts, the workshops focused on several helpful strategies that the Writing Center has identified for effective technical writing and presentation of graphical information, such as the most helpful order that sections of a report should be written, what type of visual aid should be used to present certain information, and a specified checklist of questions that the writer of a certain report or section should ask himself at different stages of the writing process. In order to encourage critical thinking and discussion, the students were reminded to carefully evaluate each of the workshop suggestions and realize that technical communication is a process unique to the specific situation of each project and student. The students were made aware that they were being taught the way that most informed communicators would choose to approach each type of report or a formal presentation. The workshop slides included assignment-specific instructions provided by the course professor, and following each workshop all of the PowerPoint slides were made available on the Writing Center web site for students to refer to while writing their reports and designing their presentations. In addition to the slides, several instructional handouts and tip sheets were also posted on line.

The various writing samples and graphics discussed during the final third of each workshop exposed students to different strategies for presenting information and allowed them to apply the information that they learned during the workshops and course lectures and practice revision skills acquired during the meetings with the course-assigned writing consultant. The topic-specific writing samples and graphics were taken from student work in the Cullen College of Engineering’s Capstone design course, ECE/MECE/INDE 4334, in the Spring semester of 2004. The senior ECE/MECE/INDE 4334 students were required to write various types of reports about semester-long projects, similar to the requirements of the mechanical engineering sophomores. Through the instructor-led analysis of the writing samples and graphics, the students developed and applied the critical thinking and revision strategies that they will use when revising their own work. Importantly, the writing samples and graphics generally reflected an equal amount of strengths and weaknesses, and students were instructed to observe and discuss both. Although they often demonstrated the effective strategies or avoidable errors described during the workshop lectures, few of the examples were a clear-cut “A” or “F” example.

Team and Individual Consultations

In addition to the support offered by the interactive workshops, a course-assigned, peer Writing Consultant specializing in engineering and technical communications met with the student in their teams and individually to review drafts of their writing assignments prior to submission to their course professor. Student teams were required to submit drafts of their team reports to the

course Writing Consultant a week in advance of their final due date. The Writing Consultant then prepared comments – both typed in an attached page and hand-written on the report itself – for discussion during the 45-minute consultations designated for each team. With all team members present, the Writing Consultant addressed the prepared comments, and the team leaders or individuals responsible for each section responded to the Consultant’s concerns. Often the Consultant and team members would work together during the consultation discussing a solution. The Writing Consultant attended each of the workshops and was provided with multiple resources for technical writing, including the assignment instructions provided by the course professor, in order to answer specific student questions.

Consistent with Writing Center procedures, the Writing Consultant generally worked first to ensure that the students understood the assignment itself and then discussed the conceptual aspects of the report, such as the audience, purpose, and form and content that should follow accordingly. After establishing the information that should be conveyed and working with the students to articulate its appropriate presentation, the Consultant then addressed the external concerns of their writing, such as the report structure and language. Linguistic issues such as word choice, clear description, and overall control of the language were of particular concern because of the relatively large number of students who consider themselves to be non-native speakers of English. As noted above more than one-quarter of the students in the class did not consider themselves native speakers of English.

Besides presenting an opportunity for students to ask questions that might have arisen during the writing process and to adjust their reports accordingly, the students were led into further clarification of their ideas through their discussions with the Writing Consultant. The dialogue of the consultation forces the students to fully articulate their ideas, which often benefits their writing, and the fact that they are conversing with a peer, rather than an academic authority such as a professor, tends to produce a free-flow of ideas that might not otherwise occur. The interaction with the Writing Consultant models the revision stage of the writing process for the students, helping them develop the skills necessary to revise their own work. Through the consultations, the students gained a better understanding of the benefit of revision in their writing. In addition to the team consultations, several students arranged individual consultations with the course Writing Consultant. During these consultations the students received one-on-one attention for their specific section of the team report or individual course assignment.

With fewer time constraints and the students’ enthusiasm to seek help and participate, the individual consultations were generally at least as productive as the team consultations. As can be expected, during the individual consultations the Writing Consultant was able to tailor the discussion according to the writing strengths and weaknesses identified in that particular student in order to maximize the benefits of the consultation.

Assessment

The assessment of this communications instruction intervention was accomplished through a survey administered in class soon after the workshops ended. Fifty-four students (out of the 56 registered for the class) completed the survey. The survey requested that the students indicate their level of agreement/disagreement with twenty-one statements related to their experience

with the Writing Center. Five of the statements were stated “negatively”, e.g., “I do not understand...” (See caption to Table 2), but are presented “positively” with reserved responses in the tabulated results in Table 2. A summary of the results is given in Table 3 and is perhaps more informative than Table 2. The statements were associated with four aspects of the intervention. The first objective was to reinforced the importance of communication skills for engineers. This issue was addressed in four of the statements as noted in the second column of Table 3, and the average response (column 3) was about halfway between “agree” and “strongly agree” (4.52). For all four of these statements there were a total of 195 “agrees” or “strongly agree” and only four “disagree” or “strongly disagree” responses out of a total of 216 (54 times 4) responses (See Table 2). This aspect of the response is represented in columns 4 and 5 of Table 3 as a 90% (194/216 x 100%) “agreement and a 2% (4/216 x 100%) “disagreement.” The same analysis was applied to the other three issues: workshop effectiveness, writing consultant

	Statements	strongly agree	agree	neutral	disagree	strongly disagree	total	mean
		5	4	3	2	1		
A.	Teaming skills will be very important to my career.	40	10	1	1	1	53	4.64
B	I better understand how the audience of a report dictates the manner in which it is presented.	22	19	12	1		54	4.15
C	I have learned how to access services to help me with my writing.	13	23	13	4	1	54	3.80
D	I have learned from the course writing consultant how to better revise my work.	10	22	13	4	4	53	3.57
E	Communication skills are important for engineers.	37	16	1			54	4.67
F	I understand how a progress report differs from a technical report.	15	17	13	6	3	54	3.65
G	I better understand how to represent information in a graphic manner.	9	21	17	7		54	3.59
H	My writing skills have improved as a result of my interaction with the course writing consultant.	7	22	18	4	3	54	3.48
I	I know how to evaluate and revise my reports accordingly.	3	32	14	3	2	54	3.57
J	I understand how the purpose of a report dictates its content.	15	15	18	4	2	54	3.69
K	Writing skills will be very important to my career.	30	15	8		1	54	4.35
L	I better understand the process of writing.	11	28	12	3		54	3.87
M	I understand how revision helps my writing.	24	17	10	2	1	54	4.13
N	I better understand how to find resources to help me with my writing.	15	21	15	2	1	54	3.87
O	I better understand how writing reports can aid in the design process.	21	22	11			54	4.19
P	I know how to find assistance to help me with my writing.	17	18	15	3	1	54	3.87
Q	I have learned how each section of a report has a specific purpose.	15	26	10	3		54	3.98
R	I have learned how to better present graphical data.	9	18	20	6	1	54	3.52
S	Presentation skills will be very important to my career.	31	15	7	1		54	4.41
T	I know how to explain graphical data in my reports.	12	22	17	3		54	3.80
U	My writing skills have improved as a result of attending the workshops.	3	23	18	8	2	54	3.31

Table 2: UH Writing Center Survey for Sophomore Design for Fall 2004. (Statements F, J, M, P, and T were reversed from negative.) 5 indicates “strongly agree”; 4, “agree”; 3, neutral; 2, “disagree”; and 1 “strongly disagree”.

effectiveness, and identification of writing resources at UH. The results are shown in Table 3. Since the magnitude of the intervention was so small (five workshops and only three team meetings with the writing consultant), the positive response is a good indication that the process is working. Some of the negative responses could possibly be traced to some students' comments on the course evaluation survey at the end of the semester that they resented the emphasis on "writing" in a "design" course. (This feeling will be best addressed as an educational issue by the course instructor rather than by changes in the intervention.) There were also isolated, anecdotal comments that occasionally the instructions of the course instructor conflicted with those of the writing consultant. (This issue, real or imagined, will be addressed with better and more frequent communications between the course instructor and the writing consultant.) The fact that seven per cent of the students felt that they did not know where to go to get help for their writing at UH while they were already participating in the process of getting that help is difficult to understand, but it is, of course, essentially impossible to receive 100% agreement on anything.

Statement Grouping*	Statements*	Average**	Agreement ***	Disagreement****
Importance of Communication Skills	AEKS	4.52	90%	2%
Workshop Effectiveness	BFGIJL MOQRT	3.81	71%	8%
Writing Consultant Effectiveness	DH	3.52	56%	14%
Identification of Writing Resources	CNP	3.84	66%	7%

* See Table 2

** 5 = strongly agree; 4 = agree; 3 = neutral; 2 = disagree; 1 = strongly disagree

*** per cent either agreeing or strongly agreeing with the statements

**** per cent either disagreeing or strongly disagreeing with the statements

Table 3: Summary of Writing Center Survey

Conclusions

The intervention of the Writing in the Discipline Program in the University of Houston Writing Center into a sophomore design course in the Department of Mechanical Engineering has been described. It was felt that additional writing (and communications) instruction was needed in this first design course, due to the reduction in the number of English courses required in the BSME curriculum and the diversity of English language competency and communications experiences of the class. Students were mandated to attend five workshops during normally scheduled class time. The workshops emphasized issues in technical communications. The student design teams were also required to submit their two progress reports and their final report

to a peer Writing Consultant at the Writing Center and to hopefully incorporate her comments and feedback into their documents before submitting them to the instructor. Student response has been positive but not overwhelmingly in support of the intervention. However, it is felt that some of the resistance (as measured in the survey) may be due to a few students resenting the new introduction of significant writing instruction into an engineering course. The intervention is being continued for the spring semester with few changes deemed necessary other than better communications among the course instructor, the workshop coordinator and the writing consultant.

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Biography

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Colley Hodges is the Program Manager of the Writing in the Disciplines (WID) Program at the University of Houston Writing Center (UHWC). He holds a B.A. (summa cum laude) in Creative Writing from UH. He works with faculty of various colleges to help integrate writing instruction into their courses and articulate effective solutions to address student writing needs.

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RICHARD BANNEROT

Richard Bannerot is a Professor of Mechanical Engineering at the University of Houston. His research interests are in the thermal sciences and in engineering design education. For the past thirteen years he has taught the required "Introduction to Design" course at the sophomore level and has been involved in the teaching of the college's capstone design course. He is a registered professional engineer in the State of Texas.