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Motivating Technical Writing through Study of the Environment

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Abstract

Today's engineers must be more than just technically competent. To be successful in our increasingly global economy in which teamwork and interdisciplinary interaction are the norm, engineers must have excellent communication skills. In recognition of industry needs, the San José State University College of Engineering redesigned its technical communication course to ensure that students graduate with writing and speaking skills that will transfer readily to their career needs and the global arena. The course aims to motivate students through exploring topics that are meaningful to them and using communication formats that they will see in the workplace. Combing technical communication with study of the environment broadens the course to meet multiple ABET outcomes. This paper describes the course goals, organization, management, selected assignments, and assessment. Assessment data indicate that at the end of the semester students, on average, have gained between 0.8 and 1.1 points on a 12-point evaluation rubric, and have gained an appreciation of the unique characteristics of and need for technical writing.

Subject Headings: Communication; Writing; Engineering Education; Teaching Methods, Environmental Awareness

Introduction

During roundtable discussions with employers in the early 1990s, San José State University (SJSU) Career Center staff found that employers in the Silicon Valley were not satisfied with the communication skills of SJSU engineering graduates. Of course, the need to improve communication skills is not unique to SJSU. "Communication skills, both written and oral, remain key to professional success within the engineering profession. … this need for stronger communication skills among engineering students, and for evaluation of programs to foster these skills, has been formally identified by the Accreditation Board of Engineering and Technology (ABET) as one of the 11 key attributes" (Bonk et al. 2002).

All students at SJSU are required to take two introductory writing classes and an oral communication class, followed by a discipline specific advanced writing class in the junior year with the course number 100W (ENGR 100W, ART 100W, SOCS 100W, etc.). The Career Center roundtable discussions suggested that this four-course sequence was not preparing students with the communication skills that employers were looking for. In response to the report from the Career Center, the College of Engineering gathered additional information from employers about their needs and revised the technical writing course to better develop the required student skills. The strategy was to focus the course on environmental issues and thus

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engage students in writing about topics closely related to their areas of academic and professional interest.

In redesigning the course, the faculty took advantage of a university general education requirement that all students take an upper division course on *Earth and the Environment*. Students can choose from among 22 courses to meet this requirement. Earth and the Environment courses are aimed at increasing students' awareness and understanding of the interaction of humans and science, as well as deepening students' "knowledge of the scientific study of the physical universe and its life forms" (SJSU 2009). Organizing the ENGR 100W course around an environmental theme provided an ideal context for the types of writing engineering graduates would experience in the workplace: emails, memos, incident reports, progress reports, feasibility studies, letters of transmittal, and proposals, to name a few. Motivating students to practice and perfect their communication skills is much easier when they understand and experience the future workplace applications. Centering the course on a theme provides continuity and focus for lectures, activities, and assignments. Combining the ENGR 100W course with the Earth and the Environment course provided the added benefit of reducing by three the number of units in the curriculum. In Spring 2004, the College of Engineering implemented a redesigned ENGR 100W, titled "Engineering Reports on the Earth and Environment."

Course Goals

Communication is necessary for career advancement. It is needed in industry for employees, at a minimum, to get jobs, hold jobs, provide customer satisfaction, and solve problems. ENGR 100W aims to fully prepare students with technical writing and speaking skills that will transfer readily to their career needs and the global arena.

The course goal is to implement effective teaching techniques to enhance engineering and business communication for today's global workplace. ENGR 100W is organized around specific objectives that lead to technical writing and speaking that is direct, convincing, and accurate. Students:

- Learn the basics of effective organizational communication.
  Messages must have clear, accurate wording, be delivered to the right people, contain the right information (focusing on purpose and audience), be in the right format (formal letter, proposal, memo, email, etc.), and be delivered on time.

- Analyze readers and supply them with appropriate information.
  It is necessary to communicate complex ideas effectively and appropriately to both general and specific audiences (technical, business, general).

- Develop real-world communication skills.
  Students learn to work with people from different majors and backgrounds, and with a variety of technologies, which are important skills for careers in the global arena.

- Understand standards, methods, and issues that are important in the workplace.

Industry models and examples are presented, including: business correspondence, progress reports, professional emails, technical instructions, incident reports, and formal and informal reports.

- Concisely and accurately convey research results.
  Students gain confidence in identifying a significant engineering problem, reviewing previous engineering research, analyzing the problem, generating findings from the analysis, drawing conclusions, making recommendations, and effectively presenting results. Instructors also help students improve research techniques, such as finding and reading professional journals and distinguishing between reliable and unreliable technical information.

As globalization and increased interdisciplinary interaction change the way that engineers work, communication skills become more important to success. Technology has become central to communication from the way engineers gather information, e.g., web sites, online databases, and journals, to the way they share information, e.g., email, instant messaging, social networking, blogs, PowerPoint, to the way they collaborate, e.g., web conferencing, Google Docs©, wikis. Addressing rapidly changing technology adds another layer of complexity to course content and delivery. As Bakos (1997) states, "This is not to suggest that the teaching profession should play a second role to technology, but rather faculty must adapt to change and prepare students to communicate effectively in oral, written and 'on-line' formats."

Course Participants

We are fortunate to have multiple majors and a diversity of students in ENGR 100W. ENGR 100W students are juniors and seniors, mostly in engineering bachelor's programs, though a few students major in technology programs. Table 1 summarizes the majors of students enrolled in the course and the approximate distribution according to the SJSU Office of Institutional Research.

Table 1: Academic Program of ENGR 100w Students

Major	Percent of Students (%)
Computer Engineering	22
Electrical Engineering	20
Mechanical Engineering	17
Civil and Environmental Engineering	15
General Engineering	8
Aerospace Engineering	5
Aviation	4
Chemical and Materials Engineering	4
Industrial/Systems Engineering	3.3
Technology	1.6
Master's students	0.1

The College of Engineering undergraduate population is approximately 14% female. About 50% are transfer students, who took the first three communications courses elsewhere. Table 2 summarizes the demographics of full-time equivalent students enrolled in the College of

Engineering in Spring 2009. All sections of ENGR 100W reflect the diversity of the college both in terms of demographics and majors, which brings richness to the discussions and the projects, providing both multi-disciplinary and multi-cultural perspectives.

Table 2: Demographics of College of Engineering Students in Spring 2009

SJSU Designation	Percent of Students (%)
Asian	26.7
Foreign	25.7
White	17.7
Hispanic	11.6
Filipino	7.2
African American	3.4
Pacific Islander	0.7
American Indian	0.2
Other	6.8

The diverse course enrollment also has its challenges. All sections enroll a number of non-native English speakers, some with low skills upon entry. Instructors encourage these students to enroll concurrently in ENGR 90W, the two-unit engineering writing clinic/workshop. Two other options are for students to regularly visit the University Writing Center (http://www.sjsu.edu/writingcenter/), which offers one-on-one tutoring as well as workshops, or the Learning Assistance Resource Center, LARC, (http://www.sjsu.edu/larc/) which provides support services, skills assessment, and tutorials.

The full spectrum of attitudes the class exhibits with respect to taking the course posses another challenge. While some clearly see the value of improving communication skills, a number of students start the semester with low motivation because they do not feel that the course will benefit them. They do not want another "English" class. Fortunately, for most, this attitude quickly changes as they see the direct relationship with their future technical careers. First, they appreciate the directness of technical writing and its various formats (progress reports, technical instructions, feasibility studies, memos, environmental impact reports, etc.). Second, they are enthusiastic and become engaged in the course's environmental topics because the subject matter's focus is scientific, technical, and relevant to their own lives.

Course Organization

The best method for improving technical communication skills is through extensive practice, critical feedback, and revision. Students need to practice, practice, practice, with instructors providing detailed feedback every step of the way. There are no short cuts. As William Zinsser (2001) wrote, “Rewriting is the essence of writing well—where the game is won or lost.” Students write in class and outside of class on a regular basis, occasionally evaluating others’ writing. Feedback is important to clarify expectations, bring about continuous improvement, correct negative habits, and reinforce positive performance. Feedback must be specific, timely, and understood. The writing involved in this course is very time-consuming, and students and instructors must manage their time accordingly.

The course meets three times per week, for a total of five hours. There are over 200 registered students each semester, enrolled into sections of approximately 25 students. Each section meets four hours a week with the same instructor: one day the section meets for two hours in a classroom to explore both environmental issues and writing techniques through lectures and interactive activities; another day the section meets for two hours in the computer lab during which students write to a prompt. Dedicating two hours a week of class time to writing ensures that all students get the consistent weekly practice and feedback they need for improvement. During the lab sessions, instructors are present to ask and answer questions from students. In contrast, relying solely on homework for practice allows many students to leave assignments to the last minute and then use shortcuts to save time, which can result in late assignments, extensive typographic and grammar errors, or even worse, plagiarism. On Fridays, all sections (200+ students) come together for one hour in the auditorium for the Environmental Lecture Series, during which a guest speaker lectures on an environmental topic. The Friday lecture series is a highlight of the course. Guest speakers include CEOs and high level managers of Silicon Valley companies, environmental engineers, faculty engaged in state-of-the-art research, representatives of local and state agencies, and occasionally, technical writers from newspapers or local technology companies.

A key to the success of this course is the College of Engineering Director of Technical Communication. With over 20 sections of technical writing taught per year, supporting more than 500 students, the Director of Technical Communication directs multiple faculty members who teach from a common syllabus and textbooks. Faculty who teach the course may have backgrounds in different disciplines of engineering or extensive industry experience in technical writing. In addition to teaching, the Director coordinates course scheduling, the syllabus, textbook selection, the Friday Environmental Lecture Series, faculty development workshops, and course assessment, as well as serving as a liaison with the university Writing Requirements Committee. The Director also coordinates writing courses at the graduate level and developmental writing courses to support students who are struggling.

The course takes advantage of an up-to-date computer lab that includes 25 computers, 2 printers, 1 projector, and an instructor computer with special capabilities—such as viewing student screens and editing in view of the class. Access to a computer lab is extremely helpful in teaching technical writing. Students use computers and the Internet in their workplaces, and using modern technology in the classroom creates a real-world environment. Students can perform research as they respond to the prompts and can easily review online models of reports, letters and other formats they are trying to emulate. Having access to current news sources, scientific literature, images, data, and online tools such as the Purdue Online Writing Lab (Purdue OWL), assists the students in composing and designing professional, polished documents. Because they are typewritten, these in-class writings are also much easier for instructors to read, assess, and evaluate. Also, at the end of each lab period students submit their work to Turnitin.com, which helps the students to recognize and avoid plagiarism.

Integrating Technical Content with Writing

Students write best when interested in the topic. When they see the assignment assisting in their career or day-to-day life, they become engaged. Students:

- Complete weekly in-class practice exercises to apply proper grammar, mechanics, sentence structure, syntax, technical format, and organization.
- Proofread and edit their own work.
- Practice peer editing.
- Revise their work based on both instructor and peer feedback.
- Read excerpts from professional writers to observe proper writing styles and techniques.
- Write on various topics, some general and others specific to their individual interests.
- Demonstrate their understanding of various technical writing formats.
- Gather diverse supporting evidence from primary and secondary sources, correctly represent the relevant information presented by these sources, and appropriately cite the sources.
- Present both informal and formal oral presentations to small groups and the class.

Table 3 summarizes ENGR 100W assignments and how they are weighted in the course grade.

Table 3: Course Assignments for ENGR 100W

Assignment	Weight
Weekly In-Class Environmental and Technical Writing Assignments	40%
Interview with an Engineer	10%
Analysis of a Professional Journal Article for Format, Readability, and Pseudoscience versus Real Science	10%
Formal Letter of Application and Resume	5%
Group Planning Proposal and Gantt Chart	10%
Culminating Project: Group Environmental Proposal with Library Research	15%
Oral Presentation of Culminating Project	5%
Exit Examination	5%

As noted previously, on a weekly basis, students spend two hours in the computer lab responding to a prompt. The responses are about 500 words. Typically, the prompt is based on the Friday lecture or on an environmental topic presented in the section and analyzed during the previous week. Often the prompts include references to current events or recent technological developments, requiring students to read newspaper articles, short journal articles, web sites, or government documents to prepare for the lab. For example, after a researcher spoke during the Friday lecture series about coral reef degradation and ocean acidification, students were asked to write a persuasive letter to Dr. Jane Lubchenco, the recently appointed Undersecretary of Commerce for Oceans and Atmosphere, recommending that she should place a high priority on researching and monitoring ocean acidification. In addition to the speaker's presentation, students were provided an extensive list of government and research web sites dedicated to coral reefs. After a Friday lecture on electronic waste, students were asked to write a memo to the engineering dean requesting a formal feasibility study on implementing an e-waste recycling program in the college. Students based their request on a pilot program under development in the Urban Planning Department.

Students are often asked to understand the global, economic, and societal context of environmental problems and solutions in their lab assignments. This fits well with ABET

criteria. For example, after an energy consultant spoke about the challenges of convincing clients to invest in energy efficiency, the prompt asked students to compose a business letter to a client proposing an energy efficiency project and providing a cost analysis to show that the project would pay for itself in a specified time period. To complete assignments such as this, students do not need a high level of design experience, simply enough to be able to understand technical content for presentation purposes. For this assignment, the instructor provided the basic elements of the proposed design and the cost analysis, requiring the students to organize the material into a persuasive proposal.

Once each semester students develop a set of instructions for an object or a process. The skills students learn through this assignment also apply to assignments in other classes, for example methods sections for lab reports and proposals for senior design projects. One technique is to bring a relatively unfamiliar object to the lab, for example a hand-crank and solar powered emergency radio, and demonstrate its features. An ideal object or process is complex enough that students must be organized about presenting the available alternatives. For example, the radio may be operated using the solar powered photovoltaic cells or by turning the hand crank to store power in a battery. These two paths need to be described distinctly and unambiguously. Students have the entire lab period to experiment with the object and write instructions for a specified audience. Students are encouraged to use graphics to illustrate important features and steps. To assist the students in creating polished and attractive instructions, the course instructor may post digital photos of the object on the course web site. Alternatively, students may draw the object using the simple drawing tools included with the word processing software. Key to the success of this assignment is identifying an object that does not have readily accessible instructions on the Internet.

Students are particularly motivated by assignments that touch them personally. Three assignments that fulfill this criterion are a resume and accompanying cover letter, a letter to a faculty member requesting a reference for a scholarship or graduate school, and an interview with a practicing engineer. Each student identifies a practicing engineer who has been working for at least five years to interview regarding what to expect in the profession and how to best prepare for a successful career. After the interview, students must write a memo to the instructor introducing the interviewee, summarizing the interview through a transcript, and reflecting on key lessons they learned. Each student also makes a short oral presentation relaying at least one key lesson to the whole class. The assignment builds confidence in interviewing, and provides practice in listening, note taking, summarizing, and developing clear, focused questions.

Students work in groups in class to brainstorm good interview questions, but the instructor also specifies several compulsory questions. The first is “What is the impact of oral and written communication on your work and your progress in your profession?” The students are consistently surprised when practitioners indicate that writing and speaking are the most important part of their jobs. Practitioners frequently say that technical writing was their most valuable course or lament that they did not have the good fortune to take technical writing in college. This not only makes the faculty smile, but also provides excellent motivation for students to work hard in the course.

The second set of compulsory questions relates to the environment. Students are given more latitude here but must ask at least two questions about environmental practices or issues at the company or in their selected profession. Typical examples are: Does the company have environmental policies? Do they have a recycling program? Is the industry governed by any government environmental regulations? What are the environmental concerns within your industry? Students share their findings through impromptu oral presentations in class. Many students are surprised by the responses. They discover that environmental concerns affect every company and every industry. This helps students understand why the college places an emphasis on the environment and also contributes to the ABET criterion of understanding the environmental context of engineering solutions.

The course provides ample opportunity for students to work in teams, both informal, usually within a single class period, and formal, during a longer term project. Students are provided some guidance in using collaborative tools such as Yahoo Groups©, Google Docs©, and the track changes feature in Microsoft Word©. Many students have had little or no previous experience working with these powerful tools. Industry is embracing wiki technology for collaborating on complex projects (Carlin 2007; Levine 2008; Levy 2009). To introduce students to this up-and-coming technology, in spring semester 2009 students in one ENGR 100W section developed a wiki on an environmental topic. Students enjoyed "publishing" their findings in a public forum, and the final product will serve as a resource for future semesters.

The culminating semester project is typically an individual or group environmentally related proposal. The proposal allows students to explore in depth topics they find interesting. Sometimes students address environmental issues they see in their own workplaces. Proposal topics span a wide range, including fitness bicycles to generate power for a health spa, greener commercial aircraft that reduce noise pollution and create a smaller carbon footprint, environmentally preferable building materials, laser technology for bird dispersion near airports, and alternative technologies and fuels for automobiles and other transportation systems. A proposal is an excellent culminating project because it integrates many of the technical communication elements students have been perfecting the entire semester: formatting; inserting charts, tables and images; paraphrasing and citing sources; compiling a reference list; explaining a process; and creating a persuasive argument and analysis. Proposals must include elements that students will encounter frequently in their professional careers such as a letter of transmittal, an executive summary, a budget, and a task schedule supplemented with a Gantt chart. Students must also deliver a concise oral presentation complete with visuals to convince their "client" that their proposal should be funded.

Integrating with the College Green Initiative

In 2007, the Charles W. Davidson College of Engineering (CoE) revised its mission and vision to reflect world developments. The new mission reads: "to educate new engineers for the new century, who are technically excellent, broadly educated, and socially responsible" (College, n.d.). The vision puts a strong emphasis on developing innovative solutions that integrate social and economic considerations and on "fostering students' moral commitment to use their education in a way that benefits not only themselves but also the world" (College, n.d). To implement this mission and vision, the CoE identified *Green and Sustainable Engineering* as an over-arching theme. To support this mission, the College has implemented a major initiative to

promote, coordinate, and facilitate research, curriculum, and activities related to the development and implementation of green and sustainable engineering practices at SJSU (Backer & Wei, 2009).

In support of the Green and Sustainable Engineering initiative, ENGR 100W faculty organized the class for several semesters around environmental issues on campus. Campus staff who could provide information about campus energy generation and consumption, water use and consumption, and solid waste and recycling were identified. Examples were the campus energy analyst in Facilities, Development and Operations, the campus Director of Energy and Utilities, the Associate Director of the cogeneration plant, and the campus Recycling and Moving Services Specialist. Speakers for the Friday ENGR 100W Environmental Lecture Series were selected with green building and renewable energies as a general theme. Speakers covered a broad range of topics from design and construction of an innovative green engineering building at Stanford University and the LEED green building program at the City of San Jose to solar energy and ocean wave energy. In addition, several of the SJSU staff described previously spoke about campus-specific issues, regulations, initiatives, and challenges.

Students were assigned related in-class assignments following each of the Friday speakers to help them digest the material and explore it in more depth. For the culminating project, students were provided with extensive data on SJSU, which included monthly power consumption for selected campus buildings, outputs of the campus cogeneration plant such as power, steam and chilled water, and campus well usage. Students were asked to conduct feasibility studies or prepare proposals to explore environmental solutions for the campus as a whole and the engineering building in particular. Projects could suggest ideas for the reduction of the consumption of water, electricity, or waste, or for using greener materials. The ENGR 100W coordinator organized optional field trips to the campus cogeneration plant and the *Green Building Exchange*, a sustainability center disseminating green building practices and showcasing vendors that supply environmentally friendly building materials.

Assessment

The College of Engineering developed a system of pre- and post-tests to measure student progress in writing. The system has several advantages. Test scores can be used to:

- measure if students are improving after four months of regular practice in the technical writing lab,
- evaluate consistency across multiple sections and instructors, and
- deliver outcomes data to each engineering program for ABET assessment and reporting.

Pre-test. The California State University system requires that each campus establish a "Graduation Writing Assessment Requirement" (GWAR) for all undergraduate and graduate students. ENGR 100W, the previously described course, is required of all undergraduate engineering, aviation, and technology students and meets the GWAR. At SJSU, a writing skills test is required before undergraduate students can enroll in the 100W writing class or other upper division general education classes. The Writing Skills Test (WST) is a standardized test implemented campus-wide by SJSU since 1986. This test is written and graded by professional off-campus graders. It consists of two parts: an objective portion that tests grammar and a timed essay written to a prompt. Table 4 describes the essay scoring rubric. Two graders read each

essay, summing their individual scores to calculate the final score for the essay. A score of 6 out of 12 on the essay, plus a passing score on the objective portion, is required to enroll in the upper division course that meets the GWAR.

Table 4: Grading Rubric for WST Essay and ENGR 100W Exit Exam

(6) Superior competence in writing on both rhetorical and syntactic levels • is effectively organized and developed • intelligently addresses the topic, showing maturity of thought and expression • uses clearly appropriate details to support a thesis or illustrate ideas • shows unity and consistent facility in use of language • demonstrates a high level of syntactic variety and appropriate word choice • is nearly free of errors
(5) Clear competence in writing on both the rhetorical and syntactic levels. May have occasional minor errors. • generally well-organized and well-developed, though it may offer fewer details than a "6“ paper • may address some parts of the topic better than others • shows unity, coherence, and progression • demonstrates some syntactic variety and range of vocabulary • displays facility in language
(4) Competence in writing on both the rhetorical and syntactic levels. • is adequately organized • addresses the topic adequately, though perhaps not completely • uses some details to support a thesis or illustrate ideas • demonstrates adequate but not distinguished facility with language and syntax • may contain some errors that obscure meaning
(3) Some developing competence in writing. Remains flawed on either the rhetorical or syntactic level or both. May reveal one or more of the following weaknesses: • inadequate development or organization • failure to support or illustrate generalizations with appropriate or sufficient detail • multiple errors in sentence structure and/or usage • inappropriate choice of words or word forms
(2) Limited competence in writing. May be seriously flawed by one or more of the following weaknesses: • failure to organize or develop • little detail or irrelevant specifics • serious and frequent errors in usage or sentence structure • problems with fluency or focus
(1) Incompetence in writing. May reveal the writer’s inability to comprehend the question, may be incoherent or impressively illogical Paper may be severely underdeveloped.
(0) Off topic or shows no response.

Post-test. To address industry concerns that graduates achieve a specified level of proficiency in communication skills, the College of Engineering developed a post-test, readily comparable to the WST. The post-test, called the Writing Evaluation Exit Exam, which consists of only a timed essay in the same format as the essay for the WST, was first implemented in Spring 2004. The College hires the same professional off-campus graders who evaluate the WST to score the students' essays, which are written during the last lab of the course. These evaluators use the same standardized rubric for evaluation. As previously stated, students must earn at least a 6 out of 12 on the WST essay to enroll in ENGR 100W, but must earn at least a 7 out of 12 on the exit exam to pass the course. While a minimum exit exam score of 7 is required to pass ENGR 100W, the average score for those who pass the class is 8.

To ensure a base level of competency, all engineering undergraduate students must pass ENGR 100W. However, students continue to perfect their communication skills in subsequent courses, particularly the senior design course. Students who do not earn a 7 must retake ENGR 100W and are encouraged to enroll in a companion developmental writing course (ENGR 90W), also within the College of Engineering. By requiring a minimum of 7 on the exit exam, the college has been able to demonstrate that all students who earn a bachelor of science in engineering meet the minimum level of technical communication skills.

Comparing pre-test and post-test scores provides the college and faculty members with measurable data on student gains. Figure 1 compares growth in essay scores for the 775 students who passed ENGR 100W from Spring 2008 to Fall 2009. Data indicate that the average difference between the exit exam and the WST scores as a function of WST score. The weakest students (those earning 6s on the WST) show the greatest gain, averaging an increase of 1.7 points between the WST and exit exam. Students scoring 9s and 10s on the WST, about 6% of registered students, show little growth as measured by the WST rubric, though faculty do see improvement in their writing. Students rarely score 11 or 12 on the WST or exit exam. Many students omit a key rubric element that is required for high scoring essays: "uses clearly appropriate details to support a thesis or illustrate ideas." Having identified this as a problem, the faculty focused on developing this skill in Fall 2009. Figure 1 indicates that compared to previous semesters Fall 2009 students of all levels exhibited increased growth from the WST to the exit exam.

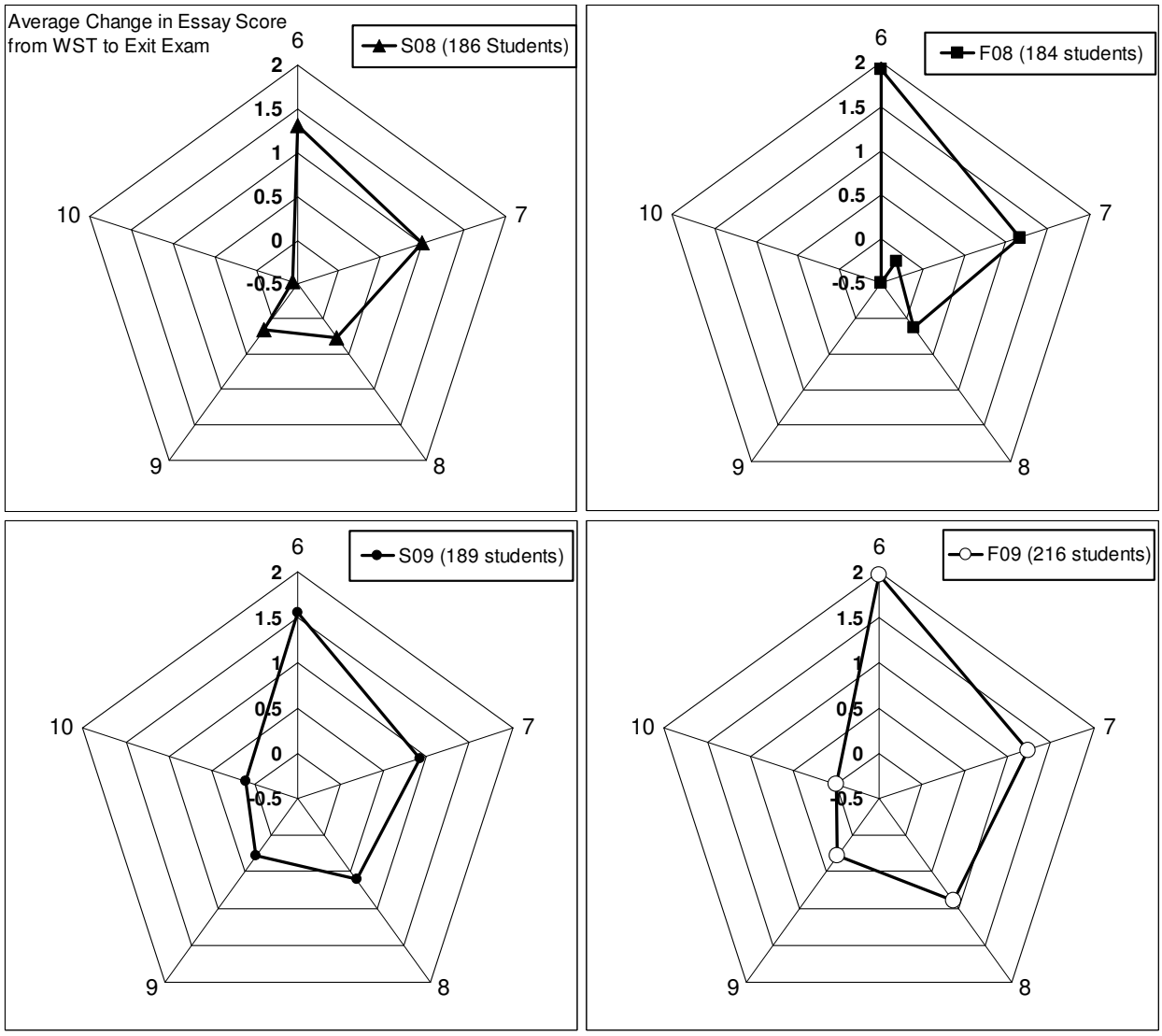

Figure 1: Average change in essay score from WST to exit exam as a function of WST score.

As shown in Table 5, over the course of the semester, students improve an average of 0.8 to 1.0 points. This means on average the students' exam scores are one point higher than the WST essay. The drop in scores in Spring 2008 and 2009 can be attributed to two factors. The first is that recently a larger percentage of the students who enter ENGR 100W have scored 8 and above on the WST, and students who earn 8 or above on the WST show less overall growth. The recent exit exam prompts have not been worded so as to compel students to provide the level of detail that leads to high exit exam scores. The exit exam prompts for Fall 2009 were designed to be more technical and to require students to use more details to support their theses. The result of Fall 2009 semester's 1) emphasis on including details and 2) more technical exit exam prompts was a significant improvement in scores, with eleven students earning an 11 and the average gain jumping to 1.14.

Table 5: Average Difference in Essay Score Between WST and Exit Exam

Semester	Average Change
S 2004	1.01
S 2005	1.06
S 2006	1.07
S 2007	1.09
S 2008	0.99
S 2009	0.84
F 2009	1.14

In any given semester about 90% of enrolled students pass the class, which is graded A, B, C, or no credit (NC). Students write at least 11,000 words per semester in ENGR 100W, and every lab product, homework assignment, and group activity is graded. We attribute the high success rate to screening entering students through the use of the WST and the extensive practice students experience throughout the semester. Overall, exit exam scores correlate closely with the instructor evaluations of student performance as shown by the comparison of exit exam scores and grades in Figure 2. The important trend revealed in Figure 2 is that 41% of students who earn a course grade of A, and only 14% of students who earn a B or C, score a 9 or above on the exit exam. Similarly, 83% of students who earn a course grade of A, 60% of student who earn a B, and only 38% of students who earn a C score an 8 or above on the exit exam. The vast majority of students who were passing the class going into the exit exam pass the exam. Those demonstrating weak writing skills throughout the course score lower than a 7. About 30% of the NC grades are students who do not bother to take the exit exam. Typically, these are students who are struggling in the class and assume they will not pass. Almost half of the students who earn a NC are extremely weak students who struggled on the WST, taking it multiple times, usually 3 or 4 but as many 15. The few students who score 7 or above on the exit exam but earn an NC in ENGR 100W do so because of plagiarism or failure to turn in a major assignment.

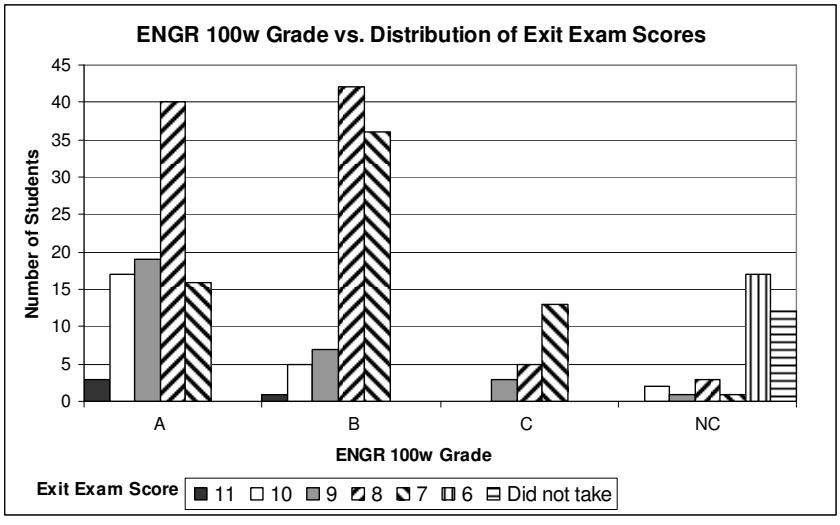

Figure 2: Comparison of exit exam scores and ENGR 100W grade.

Initially, students had trouble with the format of the assessment, having had little practice in writing an organized document in a short time span. As a motivation, instructors inform students from the beginning of the course that the weekly lab assignments are excellent practice and preparation for the exit exam. Students are now better prepared to organize, write, and proofread under limited time constraints—a skill easily transferable to industry.

In self reflections written upon completion of the course, students indicate better attitudes about technical communication, often as a result of learning about environmental content. One student wrote,

> "To be honest, I didn't want to take another writing class—but I'm glad I did. This was the most valuable course of the semester. I liked learning how to write for a technical audience and what formats will be used in my job. The environmental information was cool."

As another student noted,

> "The majority of growth in my personal writing can be seen in the organization of my documents and sentence structure. Learning to write differently in response to drastically different audiences was very new, to me. . . . as a result my writing can convey ideas to audiences a lot clearer and in a more organized structure than ever before."

Even students who have performed consistently well in previous writing classes indicate that they benefit from the class. One such student wrote,

> "Many of my professors have acknowledged my aptitude, complimenting me on my prose, sentence structure, and sophisticated range of vocabulary. However, most of these elements are not appropriate in technical writing. . . For my entire life, I've had the benefit of writing essays that do not *require* a specific audience or me having to answer a list of *specific* questions or address *specific* points. ...And most importantly, I overcame my arrogance to learn a new style of writing that's more suitable for the engineering work field."

Students appreciate the environmental content and the multi-disciplinary interaction. One student wrote,

> "When I signed up for the class, I didn't want to get up on Friday mornings. . . . But the Friday speakers were mind-blowing. I learned a lot."

Another wrote,

> "My environmental project team was incredible. We had to spend so much time together, but it was worth it. It was my first time to work with students from other engineering majors."

Conclusion and Suggestions

The communication aspects of this course provide regular writing assignments, practice in editing, and company-focused oral presentations. This course builds technical writing that is direct, convincing, and accurate. Students are able to critically review and revise their work, and not only write and speak more effectively, but also more easily and confidently. As a result they will be better prepared to integrate and apply complex skills for their professional careers in the

global arena. As Rhodes (2005) notes, "Long after most professional engineers have ceased to integrate a differential equation, they are still required to write technical reports."

An interesting, but unexpected, benefit of the pre-test, post-test assessment model is that the instructor's role, to some extent, is redefined from evaluator to mentor/coach. Although the faculty evaluate and grade all of the in-class and out-of-class assignments during the semester, they do not grade the high stakes exit exam. The weekly feedback related to organization, audience, completeness, clarity, format, and grammar prepare students for not only industry expectations, but also for the exit exam. As a result, the relationship between student and instructor becomes collaborative, focused on what is needed to ensure that the student develops the skills to succeed in the course.

Critical to the success of this program is weekly writing and feedback. At San José State, using class time and a dedicated computer lab is crucial. Without this weekly writing, students would not make the same gains. One might argue that students could use their own laptops for in-class writing if a dedicated lab were not available. However, the dedicated lab provides the advantages of the instructor computer, which can monitor and demonstrate on student computers, and the ability to turn off access to the Internet for selected assignments.

ENGR100W includes students from all majors in the College of Engineering, and the environmental theme is broad enough that students from all majors are able to explore topics that interest them. However, faculty could narrow the theme if the course were aimed at a single major. When possible, we recommend that this class not be limited to only one department. Because engineers and technical careers require communications between people with a lot of different backgrounds and jobs, ENGR 100W provides one of the only classes in the College for different majors to meet. Synergism, especially in group assignments, can be explored and achieved.

ENGR 100W has achieved its goal of creating a structured and engaging technical writing course that improves students' technique, exposes them to writing samples and projects that they will experience in the workplace, and motivates students through exploration of timely environmental topics that are both personally and professionally relevant. The high pass rate, student satisfaction, and high praise from a recent ABET evaluation team indicate that this format could be a model for other programs, in fact, it is currently under consideration by at least one other department at SJSU.

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