

Using Writing to Meet the Needs of Freshmen

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Abstract — Freshman engineering students have a number of writing assignments during the first year that are designed to meet the instructional objectives of the academic, advising, and library programs at the University of Pittsburgh's School of Engineering. The two semester writing projects are the result of a collaboration between the Freshman Program, Freshman Advising, and the Engineering Library that creates a student centered learning environment to help freshmen learn how to use communication software packages, develop research skills, make informed decisions about their future educational and career goals in engineering and help discover what engineering is.

Index Terms — Curricular Innovations, Writing to Learn, Communication Skills

INTRODUCTION

Traditional teaching methodologies have been shown to put students in a role of passive rather than active learning [1]. In addition, traditional instructional methods have also been shown to be very inadequate in terms of the promotion of deep learning and long-term retention of important concepts. Students in traditional classrooms acquire most of their "knowledge" through classroom lectures and textbook reading. A troubling fact is, after instruction, students often emerge from our classes with serious misconceptions [2 - 6].

A significant body of educational research supports the fact that students must be functionally active to learn [7 - 9]. Furthermore, Koballa, Kemp, and Evans [10] note that "ALL students must become scientifically literate if they are to function in tomorrow's society" (p. 27). Scientific literacy is of critical importance for all students at all educational levels.

The *National Science Education Standards* [11] strongly emphasize that inquiry-based techniques should form the core of what it means to learn and do science. Edwards [12] suggests that the publication of the *National Science Education Standards* offer reason to be optimistic that inquiry-based learning will become a central part of science education. Inquiry-based learning strategies originate from the constructivist model and encourage an active, hands-on approach to learning [13 - 14]. The constructivist approach embraces the idea that knowledge cannot be acquired passively [15]. In addition, the National Science Foundation currently has several programs that promote the integration of standards- and inquiry-based SMET educational materials

and instructional strategies from elementary through graduate school [16].

In recent years, a number of writing techniques have evolved that make use of various writing-to-learn strategies within the domains of engineering, mathematics, and the sciences [17 - 25]. The use of writing in introductory classes may be an effective vehicle for allowing students to enhance their critical thinking and problem-solving skills. Writing can also assist students with the identification and confrontation of personal misconceptions [26, 27].

Science classes are seen by many students to be threatening and intimidating places to be. Tobias [28, 29] also indicates that writing can serve as a means to help students relieve their anxiety and help them unlearn models and techniques that have been shown to be scientifically unsound.

This article describes a novel technique for infusing writing into the freshman engineering curriculum that is based on research the authors are conducting on using writing as a means of providing "hands on learning". [31 - 35]

PROBLEM STATEMENT

At the University of Pittsburgh all entering students are exposed to the Freshman Program that has an academic and an advising component. The mission of both components is to create a first year experience that promotes the student's continued pursuit of an engineering degree. In addition, the academic component has the mission of introducing the students to the necessary computer tools to meet the needs of their future departments, introduce the concept of teamwork, and improve the communication skills of the students. Part of the Engineering Library's mission has been to work with freshmen in order to give them a solid orientation to library research in a university setting. The problem is to create a curriculum that can satisfy all these missions.

Academic Concerns

The mission of the Freshman Program is to: Create an integrated freshman curriculum, introduce teamwork in all the freshman courses, expand the students' communication and writing skills, and introduce the necessary computer tools that the students will need in the future. Creation of a new integrated curriculum, incorporating cooperative learning and teamwork within this new curriculum was difficult but

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manageable. Even redesigning the first year engineering courses to meet the computer tools was possible. However, even with the change in the type of instruction, the traditional engineering problem solving course does not provide enough opportunities for written and oral presentation assignments to meet the needs of this mission. Thus, there was a need for an additional written report somewhere within the curriculum.

Advising Concerns

The main objectives in freshman student advising is to assist each student so they may make a smooth transition from high school to college; and aid first year engineering students in identifying the engineering program they will eventually major in. To meet this objective, Pitt developed a system that uses a undergraduate mentoring program together with staff counselors and to address the needs of the student. Based on the experience the staff has had with the students, it has become obvious that the more the advising and academic programs are integrated the more effective the advising becomes. Thus, the problem is how do you incorporate active advising into the freshman curriculum?

Library Concerns

Engineering is an increasingly interdisciplinary field. Real world problems engineers of the future will face may combine knowledge and understanding from several fields outside of their areas of expertise. While it is not reasonable to expect engineers to have mastery over all subjects, it is reasonable to expect them to be able to find and analyze relevant information as needed. It is unfortunately common to hear junior and senior students say they do not know how to conduct research within the literature of engineering; and that these research skills are required by full time and Co-op companies that employ the graduate.

Therefore, the goal from the library staff is to work with the freshman program so they can impact all the entering students early instead of waiting for the senior year design project. Thus, their concern is how to you incorporate a research report into the freshman curriculum that does not have any written assignments?

Solution

The solution was to add a number of writing assignments during the first year that are designed to meet the instructional objectives of the academic, advising, and library programs. The two semester writing projects are the result of a collaboration between these programs that creates a student centered learning environment to help freshmen learn how to use communication software packages, develop research skills, and make informed decisions about their future educational and career goals in engineering. During the first semester students research various fields of engineering and learn about companies and jobs and "hot topics" in their area of interest. The task is to answer the questions what do engineers do and what is engineering. In the process of completing this research, they collect data for the creation of a conference paper on sustainability during the second semester. The students learn library skills and resources, how to conduct research, and how to write technical papers and

make oral presentations. This project takes a giant step towards integrating the concept of advising, counseling, library research, as a basic engineering skill, and computer tool introduction into the curriculum at the first stages of a student's education.

BACKGROUND

Engineering 0011-Introduction to Engineering Analysis

All students are required to take four core courses during their first year. There are two zero-credit seminar courses and two three-credit introductory problem solving courses that are a part of this core. ENGR0011 is a required first semester three credit course, for all freshmen engineers that meets twice a week for 2 hours in a computer-equipped classroom. It is an *integrated* course that has three overall goals:

- ?? To teach the basic computer skills, and their role in problem solving,
- ?? To introduce teamwork,
- ?? Improve writing and communication skills
- ?? To begin understanding how material in the basic sciences and mathematics is used by engineers to solve practical problems of interest to society.

A portion of this course is taught interactively in a cooperative learning environment where the students work in teams to solve the course requirements. This helps meet the goal of improving teamwork and communication skills

It is the experience of the faculty that students know very little about the actual operation of a computer or computer software as problem solving tools. The students are good at using AOL instant messenger, and finding music files on the web, but when it comes to organizing files in directories, or organizing their thoughts into a structured program the vast majority of the students are lost. Thus, the main focus of ENGR0011 is to begin the process of structured thinking.

The Engineering 0012 Course

This course is a continuation of ENGR0011. The main difference is the course material centers more around the use of "C" to solve the given problem, where ENGR0011 uses "Excel", "UNIX", "HTML" and "Matlab" to produce the required output and or result. ENGR0012 is the next step in the development of the students problem solving skills. In the first semester they are introduced to all the various concepts and skills required to be successful in engineering, in this course they are required to use these skills.

In both ENGR0011 and ENGR0012 open-ended homework projects related to engineering topic areas are assigned. Here students have several options and must make efficient choices in order to solve the problem(s) at hand. These projects are intended to introduce engineering, and challenge students' judgment and creativity as well as their problem-solving abilities.

Engineering 0081 - Freshman Seminar

During the summer registration periods we ask the entering students to explain what engineering is and why they want to become an engineer. Very few students can answer

this question, with the typical answer being "I do not know". To help the students answer this question we have an Freshmen seminar, course ENGR0081 [36]. This is a required first semester course, for all freshmen engineers. It is a non-credit class, however the freshmen are graded pass/fail based on attendance and participation. The course is based on a mentoring concept; where students meet with their respective mentors once a week for an organized class. Mentors and freshman gather and get information that they can use to make their transition a success and to help form a bond between the mentor and student, they also participate in informal teambuilding activities such as: flag football, museum tours, trips to the symphony etc. With this design ENGR0081 has two main goals:

- ?? Help the students discover the field of engineering they find interesting,
- ?? Provide support in the form of peer mentors to assist the students in the transition to college.

Engineering 0082 - Freshman Seminar

Freshmen seminar, ENGR 0082, is a continuation of ENGR0081 and is also a required course, for all freshmen engineers. The design of the spring seminar session is centered on department selection. The course includes three weeks of department open houses, where each department has the flexibility to do what it chooses. Mentors and freshman still gather at other times throughout the week in order to participate in informal teambuilding activities.

Engineering Library

The Bevier Engineering Library's collection supports the studies and research of the School of Engineering's faculty, students, and staff at the University of Pittsburgh. Since engineers need to be able to conduct effective research throughout their careers, the Engineering Library is concerned with providing engineering students with the resources and services that will enable them to find useful, relevant, and authoritative information.

DESIGNING THE FALL COURSE INTEGRATED LIBRARY RESEARCH PROJECT

In the Fall of 2000, the authors proposed a number of writing activities including a simulated professional conference as the focus of freshman year [37]. The library embraced this creative approach as a means of working with the freshman. The advising program also strongly supports it as a means of improving the students understanding of the engineering profession. This project is not isolated from the rest of the curriculum, but embraces the needs of the Advising concerns, the Academic concerns and the Library concerns. Thus, the students and the entire support staff surrounding the students are all involved in the project so the students understand the importance of the project. Through the context of a conference, students are now introduced to the culture of academic research and the scholarly communication system and how the engineering profession interacts with this skill. Specifically the educational objectives of the library including introduction to some of the library's resources and research processes, and introduction

to critical thinking skills to analyze the validity and utility of information are incorporated into the project.

The ENGR0011-Introduction to Engineering Analysis group collaborators met in August 2000 to work out a research project design that would meet the objectives of all parties. Due to the class size of 380 students, it was decided that the research project should be structured so that faculty, advisors, and the library could facilitate its management. It was also decided that a trial run of writing and presenting a technical paper to a small group of their peers using PowerPoint software would best prepare the students for the conference in the spring semester. The ENGR0011 group collaborators agreed that the overall theme of the Fall library research project should focus on the student's exploration of an area of engineering that interested them.

At many universities they use hands on projects or various design projects to try and help students discover what engineering is and what engineers do. We even used this procedure for years to try and help students discover what engineering is all about. However, we were not pleased with the projects nor did we feel they were accomplishing the goal of explaining what engineers do. It was felt that by having the students take an active role in exploring their future by researching their profession we could address the academic, advising, library and student concerns. Thus, this project allows the ENGR0011 course the opportunity to introduce the required software for the project, work on improving the student's written and communication skills, addresses the advising concerns, and introduces the library skills.

The curriculum for the ENGR0081 course was integrated with the curriculum of ENGR0011 and was facilitated by 18 upper class mentors. Each freshman in ENGR0011 belonged to a Mentor Group. Due to class size and volume/turn around time of assignments, it was decided that the mentors would be responsible for providing feedback and assistance with the grading of each library research component and evaluating the final papers and presentations. Although ENGR0081 itself was non-credit course, the final paper for ENGR0081 comprised 15 percent of the student's grade in ENGR0011.

The Engineering librarians designed the assignments to expose the students to resources that the student would need to utilize throughout their undergraduate program as well as the literacy skills that would continue to serve them as professionals. The first research assignment was designed to use the Web and involved Critical thinking. This was done by having the students use the web to explore the various Engineering Societies associated with their selected major. It was decided to use the web aspect and critical thinking skills early in the process because it addressed Gen Y penchant for using this as a source of information. Assignment two further explored Careers and jobs (thus dealing with the advising component) – built on # 1 (societies—made preface to # 3 learn what is sought from engineers – i.e. what they will need to know academically). Assignment three required the students to investigate published articles, thus it started to differentiate between peer reviewed documents versus web material.

Their final assignment was then pulling together the information they had gathered from the previous three

assignments, write their final technical paper and have their PowerPoint presentation be based on this material. To further the integration with ENGR0011 the students were required to put the data collected in the first three assignments onto their web pages which were assignments in the ENGR0011 course.

Each component of the research project included a statement of purpose (or learning objective) so the students would understand why they were doing this work. Research/Resource Guides for each assignment were designed by the library staff in order to supply the students with additional guidance to the resources they would need to consult. The individual research assignments were to be due each week in order to 1) keep students on a schedule 2) allow the students to progressively build upon their research skills and 3) assist the mentors by limiting the occurrence of unrelated questions, thus enabling them to focus their feedback to the students

The Engineering Library met with the mentors in a separate session to discuss the library research project and address any of their questions or concerns. Since the mentors would be assisting with the grading the freshman students' weekly assignments, final paper, and oral presentation, the project leaders wanted to insure that the mentors were comfortable with the project and understood the referral process with regard to questions they could not answer. In addition, the Communications Department meet with the mentors and gave them guidance on how to assist and provide feedback for the students oral presentations.

Within the library, the librarians and staff met to discuss the project. A binder containing the Library Research Project was kept at the front desk of the Engineering Library. All of the library staff became familiar with the project; they were aware of which assignment the students would be working on in any given week, as well as the resources students were being asked to access and use.

The students were also informed that one of the key components of the second semester engineering course ENGR0012 would be the preparation of a formal written paper for publication and presentation at a conference to be held at the end of the school year. Given that Pitt uses an integrated curriculum approach for their freshman courses, students were told that where possible, their papers should relate to topics covered in the fall or spring semester of their Physics, Chemistry, Calculus or Engineering classes. In addition, students were to link their chosen topics to an area of engineering using the idea of sustainability in the new millennium as the common conference thread. The key idea was to expand upon the concept of curriculum integration by having students merge material from their core courses with material they had learned in their introduction to engineering seminar courses.

The above design allowed ENGR0011 to address the areas of teamwork, writing, communication, advising, mentoring, and research skills.

DESCRIPTION OF THE CONFERENCE PAPER ACTIVITY

The second semester writing assignment was designed to give students experience with all aspects of preparing a formal paper for publication and presentation. Phase I of this

activity was originally designed in the Fall 1999 at American University. Based on lessons learned during Phase I, modifications and enhancements were made to the writing activity used in the courses at AU and at Pittsburgh during the Spring 2001 semester.

The Call for Papers

The conference call for papers was distributed at the beginning of the semester. Students received a paper copy as well as an electronic copy of the call via the class web page. The abstract submission process was a web-based electronic format. In addition, because of the large class size (360 students), all papers were required to have two co-authors.

The purpose of having students prepare an abstract was threefold. First, the preparation of an abstract gave students a sense for how the abstract submission process is handled for a professional conference. Second, it provided students the incentive to choose a topic for their papers early and to begin to focus on the research aspects of the project. Third, based on experiences in Phase I of the study, it was obvious that many students had never been asked to prepare an abstract before. Many students were challenged to effectively summarize a paper they have not yet written into a 150 word abstract. Thus, this task required the students to think within the "big picture".

Notification of Acceptance of Abstracts

Once the submission process was completed, all of the abstracts were reviewed by the course instructors, to prepare a preliminary conference schedule and to make sure the paper topics were consistent with the call for papers. Some students were asked to revise their abstracts because their topics did not parallel the conference theme closely enough.

Conducting the Necessary Research

ENGR0012 is integrated with the second semester Freshman Seminar course (ENGR0082), and student mentors again provided assistance to the students during the writing of their papers. To facilitate this process, each of the 180 teams of student authors met weekly to give a short progress report. During these meetings students must demonstrate completion of various milestones set by the faculty. For example, during one weekly meeting students were required to submit an extended 2-page outline of their papers, during another they were required to submit a copy of the articles they were using for their papers, and during another they were required to submit short summaries of each of the articles they had collected thus far.

Preparing and Submitting a Formal Paper for Review

When students initially received notification that their abstracts had been accepted, they were given a copy of the formatting guidelines to be followed as they prepared their papers. The guidelines that were given to the students were essentially the same guidelines given to authors submitting a paper to the 1999 Frontiers in Education Conference held in San Juan, Puerto Rico in November 1999. Students were also given a copy of a paper written by the authors for the 1999 FIE conference that had utilized the same guidelines. The

conference used an electronic web-based format for paper submissions.

Receiving Reviewers' Feedback

All students' papers were subjected to a formal review process. Because there were 180 papers to be presented, the conference made use of 3 time slots with 10 concurrent sessions during each slot. This resulted in 30 sessions with 6 papers presented per session. Because of the large number of papers to be presented it was not possible for one person to perform all the associated reviews. To address this issue, 30 alumni volunteers from the Pittsburgh area together with 30 faculty volunteers were solicited to act as co-chairs for each session. Each session was co-chaired by one alumni and one faculty volunteer. These individuals also served as reviewers for the papers to be presented in their sessions.

The paper review was a two step process. Students were required to submit an extended outline of their papers. This outline was emailed to the session co-chairs, who then met with their students to discuss the paper outlines. After this meeting students prepared the draft version of their papers and submitted it electronically. The co-chairs were responsible for reviewing these submissions for technical content. A second meeting was held with the students to discuss the reviewers' comments. In addition to being reviewed by the co-chairs, each paper was also reviewed by a faculty member in the English department. The reviews conducted by the English faculty members focused on writing style, form, and grammar.

An additional lesson learned during Phase I was the need to include a peer review. During Phase II, a peer review process was implemented. The usefulness of this approach has been widely documented [38 - 39]. Thus, every student was assigned another student's paper to review.

In summary, this process produced 4 independent reviews, one from the English department, one from an alumni, one from a faculty member and one from a student.

Revision of Papers for Conference Proceedings

Students utilized the reviewers' comments to prepare final copies of their papers. Typical papers ranged in length from 5 - 8 formatted pages.

FEEDBACK FROM STUDENTS

Near the beginning of each semester, the students were quite apprehensive about the prospect of preparing a formal written paper. None had ever been given a writing assignment of this magnitude before. Although the students had done some writing, the task facing them seemed quite daunting. In addition, many students expressed anxiety regarding the fact that they were also being asked to present their papers orally.

On a questionnaire, students were asked to describe their overall impressions regarding the conference paper assignment. Typical student responses included:

?? *I've never written a technical paper like that before. The topic was much more involved - and required you to really understand what you were writing about.*

?? *I thought this was a difficult assignment that taught me a lot and was worth doing. It was a lot of work, but after*

doing it, I felt like I learned a lot. I never had to write a technical paper before and I'm happy that I can now say that I wrote a conference paper.

?? *I learned a lot about a subject that I would not otherwise have learned about. I had never written one of this magnitude, or that required so much in-depth research. We were allowed to pick the topic - which was nice.*

?? *I have never written any form of technical paper at all. At first, I was not very excited about the idea of writing such a paper, but I did feel that I had a very valuable experience. I feel that I have learned so much. I also appreciated you forcing us to do rough drafts, so I was able to pace myself and put more effort into it than I otherwise would have.*

At the conclusion of the conference, it was clear that the students felt that all of the time, energy, and hard work they had devoted to the preparation for the conference had paid off. Many expressed that they had experienced a fairly steep learning curve on both the content covered as well as the rules and regulations they were required to follow as they prepared their formal papers. In addition, many students expressed gratitude for the opportunity they were provided to participate in such a formal and professional activity.

RESULTS

In the first year we were able to design the basic concept of the writing and library integration into the freshman curriculum. As faculty and staff we learned a lot about what could and could not be expected from the students, how to introduce the material, how to grade the student presentations, what type of handouts and grading keys were required, what could be expected from the mentors, and all the various logistic concerns. Thus, the main results we obtained during the first year were administrative issues. We also discovered that the content in ENGR0081 and ENGR0082 had to be totally redesigned. Thus, in the second year we moved the department presentations from the Spring semester to the Fall, we added open house presentations into the Spring semester, and we extended the peer mentoring to the second semester ENGR0082 course. In addition, we added an intensive one week mentor training program to the week before school started. In this training we exposed the mentors to training in the areas of advising, diversity, communication skills, and mentoring skills.

The results from the Fall semester of the second year, supported the changes we made, as the students' acceptance of the project was much more positive than the first year. Based on the feedback from the students during their spring semester registration period at the end of the Fall semester, the project met the advising concern, since the vast majority of the students were now confused about what field of engineering they want to select. The students either found that by researching their fields and talking to fellow students in their mentoring class they were questioning their choice and wanted to learn more about all the fields of engineering, or were now convinced the field they selected was the correct field for them.

It was also clear that for the project to be successful, you must have the assignment well organized with handouts that

can walk the students through the process. You cannot assume that a freshman knows how to write a report, this was the biggest error we made in the pilot.

During the Fall of the second year we also starting getting feedback from the faculty teaching the Second year courses in the various departments. As one faculty member stated he was "blown away by the quality of the writing of his students compared to previous years". This also confirms the finding of the English department when they stated that the quality of the final papers was equivalent the results that could be expected from taking a 3 credit writing course. Thus, the goal of the library was also meet by the project. It is clear that the main reason the writing skills of our undergraduates is so poor is because they do not know how to use the library to write a research paper, and the results we are getting this year support the concept that if you teach them how to do it they will improve their skills.

SUMMARY AND CONCLUSIONS

All aspects of the first year library project, allowed students the opportunity to link the active process of writing to sound, scientific content. In addition, these activities allowed students to demonstrate their understanding of a topic or set of topics using their individual learning styles. This activity also provided the instructors with an additional assessment tool outside of the limits of more traditional assessment measures.

Writing has proven to be an effective way to assist students in articulating their thoughts. In addition, the opportunity to research and then write about a topic of personal interest can allow students a chance to demonstrate their understanding in a way traditional assessment measures do not permit. Hence, the application of a writing component into a course has enormous potential within both science and engineering communities.

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