Panel: Embedding Technical Writing with Experiential Learning Components into Engineering Curricula

Dr. Lindsay Corneal, Grand Valley State University

Lindsay Corneal is an Associate Professor in the Padnos College of Engineering and Computing at Grand Valley State University. She received her B.A.Sc. in Mechanical Engineering from the University of Windsor, a M.B.A. from Lawrence Technological University, and a Ph.D. from Michigan State University in Materials Science and Engineering.

Ms. Debbie Morrow, Grand Valley State University

Debbie Morrow currently serves as Liaison Librarian to the School of Engineering and the other units within the Padnos College of Engineering & Computing at Grand Valley State University, and to the Mathematics and Statistics departments at GVSU. In that position her primary role is to support students in courses in her liaison areas both in and outside of their classrooms. Helping students make connections between information literacy skills and the ”life long learning” skills ABET seeks to see in engineering program graduates is an ongoing challenge. Prior to becoming a Liaison Librarian, Debbie served as Systems Librarian at GVSU and at Michigan Technological University for 25 years. She earned her MLIS at the University of Illinois Urbana-Champaign in 1983.

Dr. Tracy Volz, Rice University

Tracy Volz is the Director of the Program in Writing and Communication at Rice University. She oversees the First-year Writing-intensive Seminar Program, the Center for Written, Oral, and Visual Communication, ESL prorgramming for international students, and Communication in the Disciplines projects. Prior to leading the PWC, Dr. Volz spent 15 years integrating written, oral, and visual communication into undergraduate and graduate courses in the Brown School of Engineering at Rice. Her current scholarly interest focuses on the use of flipped pedagogy in first-year engineering design. She received her Ph.D. in English from Rice University in 2001.

Dr. Ann Saterbak, Duke University

Ann Saterbak is Professor of the Practice in the Biomedical Department and Director of First-Year Engineering at Duke University. Saterbak is the lead author of the textbook, Bioengineering Fundamentals. Saterbak’s outstanding teaching was recognized through university-wide and departmental teaching awards. In 2013, Saterbak received the ASEE Biomedical Engineering Division Theo C. Pilkington Outstanding Educator Award. For her contribution to education within biomedical engineering, she was elected Fellow in the Biomedical Engineering Society and the American Society of Engineering Education.

Dr. Susan Conrad, Portland State University

Susan Conrad, Professor of Applied Linguistics, is the head of the Civil Engineering Writing Project, in which engineering faculty, engineering practitioners, and writing specialists collaborate to improve writing instruction in civil engineering courses. She has written numerous articles and books about English grammar, discourse, and corpus linguistics.

Mr. Timothy James Pfeiffer P.E., Foundation Engineering, Inc.

Mr. Pfeiffer is a senior engineer and manager at Foundation Engineering in Portland, Oregon.

Kenneth Lamb, California State Polytechnic University, Pomona

Kenneth is an Associate Professor at Cal Poly Pomona. Kenneth is a licensed Professional Engineer in Nevada with experience working on a variety of water, storm water, and waster water systems projects. He holds degrees from the University of Nevada Las Vegas (BSCE and PhD) and from Norwich University (MCE).

Dr. William A. Kitch, Angelo State University

Dr. Kitch is Professor and Chair of the David L. Hirschfeld Department of Engineering at Angelo State University. Before starting his academic career he spent 24 years as a practicing engineer in both the public and private sector. He is a registered professional engineer in both Colorado and California.

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Panel Abstract

Many engineering programs have recognized a need for discipline-specific writing instruction. Various methods have been targeted to provide students with opportunities to learn about technical writing with professional practice as the context for the writing. Input from educators and industry professionals has helped to develop the writing instruction and assessment. These valuable collaborations between industry and classroom instruction will help prepare engineering students to write in a professional setting.

Introduction & literature review

The Accreditation Board for Engineering and Technology (ABET) requires that students demonstrate an ability to communicate effectively (Student Outcome g) [1] as part of an engineering program's accreditation process. The methods in which engineering programs incorporate the writing instruction into their courses varies greatly. Some engineering programs integrate intensive writing instruction within first year level Introduction to Engineering courses [2], other programs incorporate it into upper-level theoretical courses [3], while others scaffold multiple writing topics over a series of classes [4], [5]. A recently published study by Donald et al. [6] describes the requirements of the Canadian Engineering Accreditation Board (CEAB) to include a general education component to engineering degrees that complements the technical curriculum and provides students with the broad education that will help to make them effective professionals in the wider context of their working lives. In their study, the authors conclude that the "complementary studies" courses are perceived by students as providing soft skills training and non-technical perspectives that they find somewhat valuable; but that students wished the skills and content were more explicitly integrated with or connected to their technical curriculum.

In work described by Jovanovic et al. [7], the creation of a faculty learning community containing English, Engineering, and Science scholars explored methods for engineering and science faculty to incorporate writing assignments in their undergraduate courses that allow students to transfer what they learned in English courses and apply it to their discipline-specific courses. This was found to improve students' writing in STEM courses through the connection to previous writing knowledge.

To move away from teaching writing as a purely academic endeavor, writing instruction in many disciplines has been incorporated into service learning [8] or community service writing projects [9]. There are also engineering programs working to incorporate writing instruction into courses and activities that apply writing as part of the professional practice of engineering. This has been done through field visits [10], working with local partners in a project-based experiential learning class [11], and through co-op education work experiences [12], [13]. An Australian study using "activity theory" to analyse writing practices of engineering faculty in engineering curricula concludes a majority of faculty resist seeing themselves as teachers of writing even when they themselves are competent writers in their own discipline and profession; this has consequences for the extent and efficacy of the writing instruction students receive when writing is embedded and assessed within the curriculum, and for the role modelling messages communicated to them by faculty [14].

Purpose

This panel reports on the status of several recent efforts to embed technical writing with experiential learning components into engineering curricula, based on the underlying premises that effective technical communication is necessary to future success in the profession and that engagement and effective learning occur when there is real-life practice included. Key features of each implementation are summarized in Table 1.

Table 1. Comparison of the programs described by the various panelists

Institutions involved	Undergraduate Level	Type of course	Writing focus
Grand Valley State University	Upper division	Co-op work experience	Technical proposals
Rice University	First year	Design for a community partner/client	Technical memos
Portland State University California State Polytechnic University – Pomona Howard University Lawrence Technological University	Multiple levels & institutions	Integrated into multiple courses in Civil & Environmental Engineering	Writing for professional practice (genres, language choices, grammar & mechanics)
Angelo State University	Integrated across all years	Curriculum-wide within the engineering program	Writing for professional practice

Technical Writing as a Component of Co-op Term: An Experiment in Engaged Experiential Learning

Lindsay Corneal, Ph.D., P.E. – Grand Valley State University
Debbie Morrow, MLIS – Grand Valley State University

The School of Engineering at Grand Valley State University exists within an educational context that has adopted certain liberal education principles across all colleges and curricula within the institution. All students majoring in any engineering emphasis must also complete the General Education program and University Writing Program requirements to graduate. Within this context, the School of Engineering has an industry-engaged curriculum, with a mandatory three-semester co-op program in which students gain a year of full-time paid experience in industry.

Engineering courses have traditionally taught technical writing through the use of laboratory reports or term papers. These types of writing are able to highlight the technical writing style but often lack the context of the professional work environment and its most common reasons for communication. Many employers within the co-op program at Grand Valley State University have indicated that students could benefit from additional experience communicating their ideas in writing when proposing or justifying a project or change.

In this case study, several members of a small curriculum development team reflect on the affordances and constraints imposed by the decision to develop the academic component of one required co-op employment term (specifically the second of three) into a writing-intensive course with a focus on technical writing embedded in a real-work context. Additionally, the academic content is delivered entirely online, requiring attention to standards and best practices for online instruction, while also allowing for the best practices of writing instruction, such as peer reviewing and revising. The rationales for undertaking the design, development, approvals, piloting, revising, and rollout of this course are closely aligned with the Liberal Education/Engineering & Society divisional engagement with "emphasizing the connectedness between the technical and non-technical dimensions of engineering learning and work … [And dedication to] helping engineers develop professional skills in areas such as communication, teamwork, ethical and professional responsibility, and lifelong learning.…".

The presentation will touch on course design goals and challenges, adjustments made in scaling up from a small pilot to a full cohort a year later, and revisions made in response to student, faculty, and employer input solicited formally and informally.

Using Technical Memos to Prepare Students for Professional Design Practice

Tracy Volz, Ph.D. – Rice University
Ann Saterbak, Ph.D. – Duke University

The first-year engineering design course at Rice University is one-semester course in which students work in teams to complete an authentic design project. All the design projects are drawn from the community and have a client with a vested interest in the success of the project. This experiential course mimics the professional practice of engineers in several important ways including defining the problem, prototyping and testing a physical design solution, working in teams, and documenting design decisions.

Over the course of the semester, the design teams write nine technical memos, a standard genre in engineering practice [15]. These memos require students to clearly and concisely communicate their decisions for each step of the engineering design process. In order to do this, students must construct an argument, organize information deductively, and use numbers to support their engineering analysis. In addition, students learn best practices for data presentation including how to prepare tables, figures and drawings. This process of documenting design decisions is so critical to students' understanding of the design process [16], [17] and the success of their projects that the technical memos constitute 30% of the course grade.

Many first-year students initially struggle to produce high quality technical memos. Therefore, we provide resources, processes and personnel to support student success in writing the memos. In terms of resources, we have developed clear assignment prompts, lectures, handouts, in-class activities that highlight common errors, and grading rubrics. The grading rubrics, combined with extensive formative comments in the margins of the memos, enable students to improve their writing over the course of the semester and address technical errors that have occurred during that step of the design process [18]. To encourage revision, we implemented a process that allows teams to rewrite memos that score below 85%. Finally, we recruit and train writing mentors, a cadre of upper-class engineering students who meet weekly with the teams to provide feedback on drafts of memos before they are submitted to the instructors for grading. These near-peer mentors provide timely feedback on the technical content and the quality of the writing.

In an effort to assess the quality of the teams' design decisions, the technical memos were reviewed by engineers for particular features. These assessments were instrumental in uncovering differences in student performance when the teaching methods in the course were modified. In conclusion, the writing of technical memos has been deeply integrated into applying the engineering design process in order to prepare students for engineering practice.

Bringing the Engineering Practitioner's Voice into Writing Instruction

Susan Conrad, Ph.D. – Portland State University
Kenneth W. Lamb, Ph.D., P.E. – California State Polytechnic University – Pomona
Timothy Pfeiffer, P.E. – Foundation Engineering, Inc.

Within engineering, surveys of employers and alumni have consistently emphasized the need for programs to help students develop stronger writing skills for engineering practice [19]. However, writing initiatives are often hampered by a lack of knowledge of industry writing. Engineering faculty are usually most familiar with academic writing, and research has shown that effective industry writing can differ greatly from academic writing [20], [21]. Business and technical writing instructors may know writing principles, but they rarely have extensive experience in engineering practice. To tackle these problems, we share our experiences with a project that includes practitioner collaboration and integrates practitioner expertise into writing instruction. The project focuses on civil engineering, but the approach is applicable to any field.

Sponsored by the National Science Foundation (NSF), the project uses a research-teaching-research cycle. We first researched what practitioners value in writing by analyzing effective documents from 50 firms and agencies and interviewing 20 practitioners. We then develop teaching materials that address practitioner concerns. The materials are designed to be used with existing assignments that are similar to practitioner tasks (e.g., field observation memos, technical memos, reports for clients). Practitioners review draft materials to ensure their advice is consistent with workplace writing. We pilot the materials in courses, and assess changes in student writing. Assessment results from over 20 courses at four universities have shown improvements for both global aspects of writing (e.g., organization) and discrete features (e.g., word choices, grammatical choices). Most importantly, the student writing has increased in overall effectiveness, as assessed by engineering practitioners themselves.

The practitioner input is crucial to the project's success, allowing us to identify particular concerns for writing in industry and grammar and organizational choices that address those concerns. These will be exemplified in the presentation. Because the practitioners rarely have a conscious awareness of language use, however, the project also relies on collaboration with applied linguists, who help make the difference between effective and ineffective writing choices explicit.

Integrating a practice oriented technical writing thread across the engineering curriculum

William A. Kitch, Ph.D., P.E. – Angelo State University

The Writing across the curriculum (WAC) movement which started in the 1970s and came of age in the 1980s, clearly demonstrated the value of a curricular wide approach to writing instruction. At the same time researchers clearly showed the effectiveness of these programs varies greatly and is highly dependent upon implementation strategies [22] – [25]. Researchers have also found that academic writing can differ significantly from engineering practitioner writing and therefore, fail to properly prepare students for the writing demands of the engineering profession [26], [27].

This work-in-progress presentation discusses the development of a curricular wide writing program at the David L. Hirschfeld Department of Engineering at Angelo State University. This engineering program at Angelo State University is new, having started in fall 2015. The engineering programs are designed to cultivate practice-ready engineers with the broader skills to be future leaders. Therefore, a focus on practitioner writing is important to the curriculum. The presentation discusses the challenges and constraints faced in creating this writing program, identifies collaborations within the university, and outlines how the program will be structured and assessed.

Conclusion

Practitioners don't expect that undergraduate programs can fully prepare students to write in industry. They recognize that new hires will need to be mentored in writing, just like they need mentoring for all engineering judgment. However, they would like students to be more prepared for the expectations in industry and more aware of concerns their mentors are likely to have. The panel contributors have found that it is possible to move students to be more prepared through collaborations with industry practitioners or colleagues from across the university – so when the students are passed off to the practitioners for mentoring, the graduates can have a smoother transition. Faculty can support students to develop technical writing skills by having them write in genre-specific formats common to industry such as technical memos, reports and proposals.

When incorporating technical writing instruction into a co-op term, feedback from the employers indicated a need to incorporate an oral communication component along with the writing component so that the students can present their ideas to their employers as an oral presentation to complement the written proposal. In practice, the written communication is important for maintaining documentation but the reviews with management are often done through oral presentations. The combination of the two forms of communication (written and oral) prepare the students for professional practice. From the educators' perspective, having a course that requires a written assignment that is so specific to each student's workplace experience can be a challenge when providing feedback, but also allows for the instructor to remind the students

about adapting their conceptual levels and vocabulary choices for multiple audiences within and outside of the profession.

The three-way collaboration among applied linguistics, engineering faculty, and engineering practitioners has been crucial for curricular changes across multiple courses at four universities (panelists from Portland State University, California State Polytechnic University – Pomona, and partners). Only the engineering practitioners know how factors of the industry context affect their writing and why. However, most of them do not have a conscious knowledge of language and they can't give explicit descriptions for why certain writing choices are more effective than others. Listening to the engineers, the applied linguists can translate their knowledge into the explicit descriptions that students need. At the same time, only the engineering faculty know the constraints of their classrooms and programs, and the level of knowledge that can be expected of the students, so their input is crucial for making new teaching materials practical and usable.

We have found that it does not have to take a large amount of class time to incorporate some writing skill development into an already-existing class assignment, but faculty have to be willing to assign some new materials and answer students' questions about writing. Support from instructors and peer mentors, as well as an opportunity to revise during the process, improves the quality of student writing and oral presentations. The payoff for faculty is that pre-teaching some writing skills (language and organization) is reflected in the time (and pain) saved when reading papers later.

Questions for the Panel

- If you have revised your curriculum to include authentic experience-based writing instruction and assignments, what constraints or opportunities drove the course(s) you targeted?
- What real-world/real-work communication situations (written or oral) did you choose to demonstrate professional communication competency? How have students, industry partners, and/or faculty evaluated (formally or anecdotally) the performance of students in these assignments?
- What kind of assessments have informed or validated your design and incorporation of authentic experience-based writing instruction and assignments into your engineering curriculum?
- What have been the biggest challenges in the approach you have taken, and how have you addressed them?
- If you had known when you started what you know now, what would you do differently?

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