Training in Technical Writing for Engineering Graduate Students

Susan Wainscott, Julie Longo

University of Nevada, Las Vegas, NV

Abstract

Most types of writing that engineering students need to master in order to communicate their research efforts can be classified as technical writing. Four years ago, UNLV's Howard R. Hughes College of Engineering began to offer their graduate students a free technical writing workshop series to improve students' success rate in acceptance of papers for conferences and journals and award of graduate fellowships. Co-taught by the college's Technical Writer and the university's Science, Technology, Engineering and Mathematics (STEM) Librarian, the workshops offered in the fall semester include training in reference management systems and basic information literacy. The spring semester workshops focus on how to prepare papers for submittal to conferences and journals and technical reports as part of the requirements for grant funding. The keystone workshop of this series, offered in the fall and spring semesters, is *Literature Review for Engineers: How to Search, How to Write.* During this workshop, the STEM Librarian describes a quality search process and demonstrates methods to organize and evaluate different forms of literature and the Technical Writer describes the writing of a literature review as consisting of three levels. The final workshop of the academic year is a *Technical Writing Intensive*, during which the students work on their papers and reports. They are encouraged to bring their dissertations or theses as well, and are provided with one-on-one counseling from the instructors. All workshops include active learning and lecture as instruction methods.

Introduction

Engineering graduate students typically complete a research project and write a thesis or dissertation that includes a literature review. At the University of Nevada, Las Vegas (UNLV), engineering graduate students also are encouraged to submit papers to conferences and journals as well as participate in writing technical reports required by federal or state grant-funding agencies. Students also may apply for graduate fellowships that require a description of the applicant's research project. The term 'technical writing' is used hereafter to describe the forms of writing that the students encounter as they attempt to describe and discuss their research.

Conducting a literature review requires a variety of skills, including information literacy, critical reading, and composition as well as time management. While faculty and program staff may assume that entering graduate students are equipped with these skills, many are not[1]. In fact, many graduate students experience significant barriers to initiating and completing quality literature reviews, including library and composition anxiety, with higher levels of anxiety correlated with lower scores on literature review assignments [2].

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Library anxiety is a complex set of emotions or an affective state that library users, including students, may experience when faced either with the prospect of using unfamiliar library resources and facilities or when interacting with library staff. Library anxiety may delay or even stop the student from attempting to use recommended but unfamiliar library resources[3] or cause them to delay or end their information search attempts out of frustration rather than a sense of completion[4]. Library anxiety as described by Onwuegbuzie[5] can include "interpersonal anxiety, perceived library competence, perceived comfort with the library" as well as "location anxiety" of materials in the library, "mechanical anxiety" related to equipment and tools, and "resource anxiety" regarding the delay in acquiring resources, which also can be described as interlibrary loan anxiety. While graduate students appear to have lower levels of library anxiety than do undergraduates[6], it does affect them. Moreover, international students and those for whom English is not their native language may experience increased levels of library anxiety[7].

Composition anxiety, otherwise known as writer's block, is a set of emotions leading to avoidance behaviors and related to feelings of lack of competency in writing[8]. Composition anxiety as described by Onwuegbuzie[9] can include "content anxiety" regarding the student's writing; "format and organizational anxiety" when using a style guide; "mechanical anxiety" when using a computer, software, or file storage; and "fear of negative evaluation". This affective state may be experienced by both undergraduates and graduate students as well as professionals[10] .

Levels of composition anxiety can be increased by compulsory, high stakes assignments or writing courses[11]. This anxiety may increase further when compounded by the trepidation many graduate students experience when making the transition from student to independent scholar[12]. Compounding the apparently common composition anxiety among graduate students in general, there is a prevalent stereotype that engineers are poor communicators. A very pervasive cultural belief related to communication skills, particularly written communication, exists among engineers; this is reflected in a currently popular T-shirt, as shown in Figure 1.

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Figure 1. A popular T-shirt reflecting a belief among engineers that they do not have good communication skills[13] © Robin Lund.

In fact, high levels of composition anxiety as well as these prevalent attitudes about and among engineers may encourage engineering students to avoid efforts to improve their communication skills. This resigned attitude will hamper their success as students and professionals, particularly if they continue in academia, where grant writing and publishing are of paramount importance.

The negative emotions associated with higher levels of library and composition anxiety may lead to self-defeating strategies among students when conducting literature reviews[14] . Several interventions and instruction offerings have been found to reduce one or both forms of anxiety. As described earlier, those students who are experiencing difficulty with English as their non-dominant language – either because it is not their native language or with English as their first language but having developed poor language skills – may require instruction and interventions that pay particular attention to their cultures and affective states[15]. In addition, the format of instruction will affect students with different preferred learning styles in different ways. Of note, although many students express a dislike of group work, it is commonly thought to be among the most effective learning activities, as it necessitates active learning activities[16]. However, some international students may find active learning at odds with the style of instruction with which they are more familiar. Carefully structured small-group activities[17] and use of a variety of learning activities to appeal to a variety of learning style preferences[18] may provide the best approach to group instruction to reduce library and composition anxiety.

Integration of library and composition anxiety-reducing instruction into credit-bearing courses, such as research methods courses, may provide benefit to students[19]. Direct instruction by faculty who also may be some students' academic advisors, however, may impede student involvement in group discussions or questioning that may reveal ignorance or vulnerability on the part of the student[20]. Further, non-compulsory workshops provided by librarians and other experts may

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alleviate library and composition anxiety[21, 22]; however, the students must be motivated to make the time to attend these instructional sessions[23]. Also of value are workshops co-taught by two or more faculty or program staff who model the behaviors and describe first-hand experience with the habits of practice expected of academic professionals[24, 25]. Clearly, interventions such as non-credit-bearing workshops can lead to greater competence and confidence in the literature process[26], and can assist graduate students in their transition to become independent scholars[27].

Background

Four years ago, the Howard R. Hughes College of Engineering at the University of Nevada, Las Vegas (UNLV), began to offer the graduate students a free workshop series on technical writing to improve their success rate in acceptance of papers, reports, dissertations, theses, and graduate fellowships. The planning for these workshops was based on ideas from Dr. Mohamed Trabia, Associate Dean for Research, Graduate Studies, and Computing at the College of Engineering; he had been advocating for some time on the need to provide training in writing and communications skills to engineering students. These skills would be useful both while pursuing their degrees as well as in preparation for future jobs in industry or academia. All costs pertaining to the workshops were paid by the Dean's Office, and the Technical Writer of the college was responsible for planning the workshops each year.

In Academic Year 2011 – 2012, which was the first year these workshops were held, three presentations were given specific to technical writing. The first, held in October 2011, was a tutorial on RefWorks software given by the (former) Engineering Librarian. In February 2012, a three-hour presentation on technical writing for papers and proposals was given by the Technical Writer. In March 2012, those students who attended the February presentation were invited to attend the Technical Writing Intensive, during which they brought their own papers, reports, theses, and dissertations, among other projects. This three-hour training session was broken up into five segments, each with a 10-minute refresher on a key point, and then 20 minutes in which the students work on their own material and receive individual coaching.

Evolving Structure of the Technical Writing Workshop Series

Over time, the Technical Writing series evolved based on feedback from the engineering graduate students as well as their faculty advisors, as shown in Table 1. All the workshops take place on Friday mornings, in an effort to avoid conflict with required courses the graduate students may be taking. The workshops range in duration from one to three hours. Percentage of enrolled graduate students attending these workshops has ranged from 3% to 14%.

During the past two years, the series has begun in September with an hour-long introduction to all the resources that the engineering graduate students have at their disposal to help them with their writing projects. These resources include:

1. Thesis and dissertation information from the Graduate College, a website entitled *Resources for Proposals, Papers, and Reports*, provided by the College of Engineering;[28]
2. Information regarding UNLV's Writing Center, which provides online assistance as well as seminars and one-on-one counseling;[29]

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3. Online resources for Engineering and Computer Science from UNLV's University Libraries;[30] and
4. Resources of UNLV's Graduate College.[31]

In addition, this introductory workshop has gone over the resources provided by the Technical Writer of the College of Engineering and the Science, Technology, Engineering, and Mathematics (STEM) Librarian. Finally, the schedule of other technical writing workshops for that year has been presented.

After the *Introduction to Technical Writing* workshop in September, the next two workshops focus on training the students on RefWorks software, which is available for free through UNLV's Office of Information Technology. The STEM Librarian provides this training, both in the basics of RefWorks as well as advanced techniques, particularly how to use Write N Cite.

The last workshop of the fall semester, *Writing a Literature Review*, is three hours long, and addresses how to do a quality literature search and how to write a literature review. Details of this workshop are presented in the next section of this paper. Beginning with the literature review workshop, the students must demonstrate a commitment to their own professional development in order to attend. For this and each of the following workshops, students must register in advance, bring their own work and equipment, and prepare an assignment in advance of the workshop. In Spring 2015, a second session of this workshop was provided and was well-attended.

Table 1. Technical Writing Workshops at UNLV's College of Engineering

Workshop Title	Date	Attended	Percentage of Enrollment
2011 – 2012 Total College of Engineering (COE) Graduate Enrollment: 230			
RefWorks Tutorial for Engineers	October 2011	12	5
Technical Writing for Papers and Proposals	February 2012	25	11
Intensive on Technical Writing	March 2012	23	10
2012 – 2013 Total COE Graduate Enrollment: 214			
Engaging Best Practices to Successfully Publish a Journal Article: for Engineers	September 2012	22	10
RefWorks Tutorial for Engineers	September 2012	8	4
The Basics of Technical Writing: Session 1	February 2013	24	11
The Basics of Technical Writing: Session 2	March 2013	23	11
Intensive: Preparing a Paper for Publication	April 2013	11	5
2013 – 2014 Total COE Graduate Enrollment: 231			
Introduction to Technical Writing	September 2013	25	11
RefWorks I for Engineers: The Basics	September 2013	17	7
RefWorks II for Engineers: Advanced Techniques	October 2013	17	7
Writing a Literature Review for Engineers	November 2013	17	7
Technical Writing for Papers, Reports, and Proposals	February 2014	21	9
RefWorks for Engineers (I and II combined)	March 2014	6	3
Preparing a Grant Fellowship Application	April 2014	7	3
Intensive on Technical Writing for Engineers	May 2014	10	4

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Workshop Title	Date	Attended	Percentage of Enrollment
2014 – 2015 Total COE Graduate Enrollment: 229			
Introduction to Technical Writing	September 2014	18	8
RefWorks I for Engineers: The Basics	September 2014	15	7
RefWorks II for Engineers: Advanced Techniques	October 2014	9	4
How to Conduct and Write an Effective Literature Review	November 2014	17	7
How to Prepare a Paper for Publication	February 2015	29	13
How to Prepare a Technical Report	March 2015	20	9
How to Conduct and Write an Effective Literature Review	March 2015	32	14
Technical Writing Intensive	April 2015	TBD	TBD

In the Spring semester, the focus moves towards *How to Prepare a Paper for Publication* and *How to Prepare a Technical Report*, the latter being an important skill since most grants require interim and final reports to the funding agency. Finally, the *Technical Writing Intensive* is an invitation only workshop, offered only to students who have attended the Literature Review, Paper, or Report workshops. The attendance for this workshop generally is small; however, these are the students who have attended three or more workshops over the year and are engaged in improving their technical writing skills. The students who go through the Intensive – in which they work on their own papers, dissertations, theses, reports, or graduate fellowship applications – receive individual counseling from the instructors during the workshop.

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Literature Review Workshop

The keystone workshop of this series is *Literature Review: How to Search, How to Write*. Instruction methods include active learning as well as lecture. This is the first workshop in the series where pre-registration is required. After signing in and receiving handouts, the students may select their seats and set up their computer or tablet. The STEM Librarian and Technical Writer mingle informally with the students until the workshop begins.

The Ice Breaker

The three-hour workshop begins with an 'ice breaker' to address library anxiety and fear of writing by asking the students how they *really* feel about writing literature reviews. After some diffidence and caution, someone offers that they hate it. This triggers a whole slew of responses: "I would rather be doing math," "I am scared of writing," and so forth.

Once their concerns and fears about writing are acknowledged in the ice breaker, the next step is to generate an awareness of how important communication skills, especially writing skills, will affect the students' careers. A discussion ensues to share the experiences of the instructors and students in the publishing process in order to create this awareness. This dialogue touches on skills that result in a significant success rate in the acceptance of papers by journals and conferences, among other venues. At this point, the students realize why good writing skills are important to them. Now, they can focus on the next two segments: how to conduct a quality literature search and how to write a literature review.

How to Conduct a Quality Literature Search

Next, is an active learning segment, involving small groups of students discussing the tools and techniques they have used to complete a literature review; afterwards, they share key points with the whole group. The instructors also share their best and least successful practices and favorite tools during this discussion, including a discussion of techniques to avoid plagiarism. Next, the STEM Librarian provides a lecture describing a quality search process and demonstrating methods to discover, translate, organize, evaluate, store, and cite different forms of literature. This segment highlights tools and techniques not already described by the students during the earlier discussion. Student volunteers are brought to the front of the room to demonstrate tools, and in particular, how to navigate successfully an unfamiliar search interface and how to request materials through interlibrary loan. Handouts are provided with tool names, samples of tools interfaces, and contact information for the STEM Librarian and UNLV Libraries.

How to Write a Literature Review

After a break, the Technical Writer uses the next hour and a half to describe the steps in writing a literature review. This process is presented in three levels of mastery. Level 1, essentially a tabular bibliographic annotation, is expected of an undergraduate student; however, many workshop participants identify their writing at this level. The workshop provides the students the skills to ensure that if they are writing a Level 1 literature review, at least it is a good quality literature review at that level.

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Level 2 moves from annotated bibliography to finding patterns among the literature selected and to contrast and compare the authors' findings. According to Webster and Watson[32], this level moves from being author-centric, as with Level 1, to concept-centric. In other words, the student is asked to organize the material around key concepts. It is emphasized in the workshop that this is the level that graduate students are expected to achieve.

At this point, the workshop moves into an active learning segment, in which pairs of students work together to draft and then analyze each other's literature reviews. The period of time given to these students generally allows enough time for them to create a Level 1 literature review of perhaps one, maybe two works. It is intended that they might realize that it would be useful to form writing groups to continue the peer review process after the workshop ends. After the active learning segment, the workshop continues with a description of a Level 3 literature review, as incentive for continued learning.

The key feature of a Level 3 literature review is synthesis of the material[33]. It has a narrative quality and reflects a thorough understanding of the field, often gained only by experience. During the workshop, a Level 3 literature review is described; however, it is made clear to the graduate students that they are not expected to achieve this level, although they are welcome to try. This level of writing is expected of academic faculty, and many of the students who attend this workshop are in the process of obtaining their Ph.D. degrees with the intention of an academic career. In addition, at UNLV's College of Engineering, many of the graduate students are encouraged to co-author papers with faculty, who would prefer a Level 3 literature review be written.

Breaking the writing process into three levels is something that engineering students can understand and get excited about. Use of a table for the draft of a Level 1 literature review appears to decrease composition anxiety. Further, it gives them scaffolded, achievable goals for their professional development.

Assessment

The learning outcomes for the workshop series are:

1. Students will discover that their lack of familiarity with the library and/or particular library resources is not a reflection of their intelligence, and will be willing to attempt new tools.
2. Students will use tools and resources for research and writing that they discovered and demonstrated in the workshop.
3. Students will overcome anxiety about asking questions of the Librarian, and seek out assistance or advice as they complete their literature search tasks.
4. Students will realize and come to grips with some of their fears about writing in order to move past these fears.
5. Students will realize how important writing skills are for their success in college as well as in their career.

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6. Students will have a desire to continue developing their writing skills after the workshop series is complete and have developed a commitment to lifelong learning.

During the first two years of this workshop series, the attendees were surveyed as to the usefulness of these courses. Their comments helped modify and refine the workshops into what they are today. For example, earlier workshops had such feedback requesting that more time was spent on a couple of key topics and to provide more examples of the approaches being discussed. Later workshops accommodated this type of feedback. Another type of feedback was in the form of specific questions the graduate student had regarding referencing software, for example. In these cases, either the STEM Librarian or the Technical Writer contacted the student directly to provide additional guidance. The workshops continue to be modified and refined based on written and verbal feedback provided by the students as well as by their faculty advisors.

Other methods of refining the course material to keep the workshops relevant to the needs of the students included feedback provided by their faculty advisors. One example of this feedback includes requests by faculty to train students about plagiarism and ethics in publishing. In fact, the *Writing the Literature Review* workshop was developed as a direct response to an overwhelming request by faculty for this type of training for the engineering graduate students.

Conclusion

Anecdotal evidence for the series' success is strong. During the 2013-2014 academic year, most students who have completed the series won 'best thesis' and 'best dissertation' awards as well as received graduate fellowships and financial prizes. One graduate student, upon taking these workshops, had her technical report published[35]. Several attendees have requested reference consultations or other assistance from the STEM Librarian. Many faculty send graduate students who are co-authoring papers or preparing grant-related reports to the Technical Writer for assistance. Several faculty now require workshop attendance for their graduate students. Despite this strong anecdotal evidence, this workshop series would benefit from more formal assessment and an assessment plan is in development.

In 2014, the UNLV Libraries successfully nominated the workshops for inclusion in the Graduate College Research Certificate Program[34]. Inclusion in the certificate program will provide an external motivation for participation, as students who complete six of the approved campus workshops and then complete a presentation of their research at an annual campus symposium or professional conference will receive a program completion notation on their university transcript.

Changes in the workshop series continue in response to informal feedback. For spring 2015, an additional *Writing the Literature Review* workshop was offered because most graduate students and their faculty have indicated that this content is essential to their success. Additionally, the spring 2015 workshop series is open to registrants from all STEM academic units. In fall 2015, the RefWorks workshops will be expanded in content to discuss several available reference management tools. Given the quickly changing capabilities of many referencing software tools,

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including some that are open access, future workshops will be entitled *How to Use Referencing Software for Research,* and will cover several different tools.

While these workshops are designed to be non-compulsory, the College of Engineering seeks to increase attendance. In the 2014-2015 academic year, UNLV's College of Engineering had 229 graduate students, and the highest percentage of enrolled engineering graduate student attendance was 14%. Some of these students had attended the workshop series the previous year, and some students will repeat the same workshop to gain additional knowledge and assistance. Future study is underway to investigate how to improve attendance and implement more formal assessment of student learning in each workshop.

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