



## **Extending WID to Train Mechanical Engineering GTAs to Evaluate Student Writing**

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### **Abstract**

Beyond first-year composition, the undergraduate mechanical engineering curriculum provides few opportunities for students to develop technical writing skills. One underutilized path for students to strengthen those skills is the required sequence of laboratory courses, where students write reports that are evaluated by graduate teaching assistants (GTAs), many of whom speak English as a second language. Historically, engineering GTAs have not been trained in formative assessment techniques to help students improve their technical writing skills. This paper details a comprehensive study of a GTA training program implemented in a large mechanical engineering department. Situated within the field of Writing Across the Curriculum/Writing in the Disciplines, the program was developed to meet the unique needs of the department's GTAs and address perceived deficiencies in undergraduate student writing by teaching best practices in writing evaluation. Two methods were used to assess the efficacy of this program: 1) Qualitative methods such as interviews and an open-ended survey were used to gain the perspective of the GTAs and their students on a variety of issues; and 2) A summative assessment compared Senior Capstone Design final reports completed prior to the program's implementation to reports completed three years later to gauge improvement in clarity and concision. This research is relevant to engineering programs seeking to improve the communication skills of their undergraduate students. The program used limited staff/faculty resources to extend the knowledge and skills of its GTAs and reach all its undergraduate students through existing required courses.

### **Introduction**

Beyond first-year composition, the typical undergraduate mechanical engineering curriculum provides few opportunities for students to develop technical writing skills without a concerted effort by faculty to incorporate writing into their courses [1-2]. One underutilized path for BSME students to strengthen those skills is the required sequence of laboratory courses, where they compose lab reports, usually evaluated by graduate teaching assistants (GTAs), many of whom speak English as a second language. Historically, engineering GTAs have not been trained in evaluating student writing using formative assessment to help students improve their technical communication skills.

This paper provides an overview of a comprehensive research study of a GTA training program implemented in the Department of Mechanical Engineering-Engineering Mechanics at Michigan Technological University, with more than 1300 undergraduate students enrolled in the major. Situated within the field of Writing Across the Curriculum/Writing in the Disciplines, the program was developed to meet the unique needs of the department's GTAs and address perceived deficiencies in undergraduate student technical writing by teaching best practices in writing evaluation. In no way do I mean to imply that ME GTAs trained in the program actually teach technical communication as a discipline in their lab courses. Rather, the GTAs play an important role in introducing undergraduate students to the concept of "writing as engineers" [3],

using the terminology learned in engineering theory courses to craft lab reports, a precursor to the technical reports they are likely to produce on the job.

Two distinct methods were used to assess the efficacy of this program. Qualitative methods including interviews, roundtable discussions, and an open-ended survey helped gauge GTA needs and performance as well as assess the value of instructional tools developed to assist GTAs and students. Also, a summative assessment of undergraduate student writing compared Senior Capstone Design final reports completed prior to when the GTA training program was implemented and similar reports completed three years following implementation.

This research is relevant to undergraduate engineering programs seeking to improve the communication skills of their undergraduate students and Writing Across the Curriculum programs engaged in training faculty and GTAs on incorporating writing into the classroom. The training program used limited staff/faculty resources to extend the knowledge and skills of its GTAs and reach all its undergraduate students through existing required courses.

### Identifying a Need

Up until fall 2014, when a new curriculum was implemented, students working towards a Bachelor of Science degree in mechanical engineering (BSME) at Michigan Tech were required to take a sequence of three laboratory courses in which they wrote at least two dozen lab reports total, both as individuals and in teams of two to three students. The courses, and the year and order in which they were taken, are MEEM 2500 Integrated Manufacturing and Design (second year), MEEM 3220 Energy Lab (third year), and MEEM 3000 Mechanical Engineering Lab (third or fourth year). Since there were limited opportunities for undergraduate students to develop their technical writing prowess outside of this course sequence, these lab courses were a natural target for the attention of the department's technical communication advisor. All three courses included technical communication as a learning outcome and had a moderate or high importance relationship to ABET program outcome "g" (ability to communicate ideas effectively) [4]. However, little effort had heretofore been spent on actually teaching technical communication principles in these courses, either during lab lectures or through detailed feedback on the students' lab reports. Based on the author's years of experience in working with Senior Capstone Design students and faculty, it was clear that the students needed more feedback on their writing earlier in the curriculum. The question was, how might we ensure they receive effective instruction when resources, especially time, were limited? The answer was to better utilize an existing resource – the GTAs who assessed student work.

### Evolution of GTAs and Writing in Engineering

In the last fifty years, the literature on GTA training has evolved from non-existent to discipline-specific, with the need for such training undisputed but the content of the training of more interest lately [5-9]. In addition, GTA self-efficacy, which involves "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" [10], has also been the subject of research [11-12]. Additional research has been done in training GTAs to teach writing in composition courses [13-15] and exploring the special needs of Chinese GTAs teaching composition to native English-speaking students [16]. Rodrigue [17] traced the

evolution of training GTAs to teach writing in the disciplines via established Writing Across the Curriculum (WAC) programs, beginning in the 1970s when WAC administrators saw an opportunity to counter faculty resistance to disciplinary writing initiatives by recruiting GTAs to teach writing recitation sessions connected to faculty-taught lecture courses [18]. Since then, programs like those at Cornell University and the University of Minnesota provide voluntary training, some with stipends provided, to GTAs in disciplinary writing instruction and focus on teaching the writing process, assignment development, and evaluation of student writing [17]. Content is usually presented in one- or two-day seminars prior to the start of classes or spread out over a series of shorter sessions during the semester. Many programs also have a mentorship component, where GTAs are paired with writing faculty and/or more experienced GTAs with whom they are expected to meet weekly or bi-weekly to discuss assignments, questions, and concerns, and share ideas [17].

However, it is still much less common for disciplines outside of the humanities and social sciences to require their GTAs to undergo training in best practices in writing instruction and evaluation methods. Although a bit out of date now, a national survey of GTA training programs revealed that not a single STEM-focused discipline addressed the evaluation of student writing with their participants [19]. Development of training in effectively responding to student writing in engineering has not been explored at all. Literature on programs specifically targeted to training engineering GTAs or STEM (Science, Technology, Engineering, and Math) GTAs in general to teach and evaluate technical writing in their disciplinary undergraduate courses is sparse. Taylor [20] studied the evaluation practices of mechanical engineering GTAs and developed a rubric for them to encourage consistency and expediency and trained them to use the rubric, but the training did not include instruction in the writing process. Part of this lack of published research might stem from the belief that GTAs who speak English as a Second Language (ESL) are not capable of evaluating domestic student writing. This resistance to the idea of training ESL GTAs is rooted in the outdated belief that good writing can be reduced to proper grammar, punctuation, and style. The thought is that if someone has not mastered the minutia of English mechanics (this supposition about NNES students is problematic itself), that person is unlikely to be able to teach others those rules. It is true that people who speak English as a second language struggle to write academic papers in English [21]. However, there is also bias on the part of American academics and undergraduate students with regard to language ability when a non-native speaker of English steps into the role of instructor [22-23]. This bias might be overcome if GTAs are trained in a rhetorical approach to technical writing instruction, one that focused on content and the relationship between the writer and the audience, which is the focus of this research, as opposed to an instrumental approach focused on formats and mechanics [24].

## Research Questions

This research focused on two questions. First, what effects did a set of tools (guidelines and rubrics developed by the lab teaching team) and additional training in writing evaluation have on GTA performance, as measured by their own feedback during and after the training as well as feedback from students?

Second, what effects did the tools and training of the GTAs have on the technical writing ability of the undergraduate students once they completed all three lab courses? Once they reached Senior Capstone Design, did their reports show improved attention to audience and context in the engineering analysis sections compared to the reports of students who completed the three lab courses with GTAs who had not undergone the training and did not have access to the tools we developed?

#### Rationale for Study/Significance

This research is significant in two ways. First, as the United States increases the emphasis on STEM in higher education, there will likely be more undergraduate students and graduate students in these programs [25]. Further, it is also likely that the proportion of graduate students who speak English as a second language will increase as more students from Asian countries come to the U.S. for advanced education in STEM fields. Thus, there will be a need for programs that effectively train GTAs in all aspects of classroom instruction and management, helping them develop self-confidence in their teaching and evaluation abilities, which not only improves their performance but the learning experience of their students as well. Writing Across the Curriculum programs will find this research particularly helpful if they wish to incorporate GTAs in the disciplines into their faculty training programs. This research reveals an opportunity for interdisciplinarity in that STEM GTAs can work with, and learn from, GTAs or faculty in other fields such as composition, English, technical communication, or social sciences and further refine the methods employed in this program to meet their own unique needs.

This research is also significant because of its structure and location. It is no secret that university resources are already stretched thin. The research in question was conducted in a large research-active mechanical engineering program. Just one staff member actively manages the program and spends an estimated twenty to twenty-five hours a semester on preparation, training sessions, meetings, and documentation, with most of that time investment coming at the beginning and end of each semester. Such a program could be easily scaled to a larger or smaller institution and tailored to the specific needs of any degree program or discipline.

#### Methodology/Methods

This research is multidimensional in that it pulls together a broad array of methods/methodologies from different fields to provide a more complete picture of the training program's effectiveness [26-27]. In addition to the aforementioned field of Writing Across the Curriculum/Writing in the Disciplines, this research draws from the fields of technical communication, rhetoric, pedagogy studies, and feminist epistemology, the latter of which will not be discussed in this paper for the sake of brevity.

I used qualitative research methods such as open-ended oral and written interviews and surveys to gather information and then use thematic analysis to explore the responses [28-31]. Qualitative research methodology is useful in analyzing texts such as extensive survey responses because it goes beyond a simple counting of types of responses. Weisse notes that qualitative methods work best when researchers want to capture in-depth information to achieve a fuller understanding of the respondent's position [29].

Finally, the GTA training program is based on formative assessment theory – that students learn by receiving feedback on their work and then incorporating that feedback to improve performance in the future [32]. Formative assessment can be a key part of the learning process in that a student produces a product on which an evaluator provides feedback and the student learns from the feedback, “forming” new knowledge [32]. Such assessment can be informal (feedback on drafts, immediate responses to student questions or presentations in class) or formal (graded work such as the lab reports that GTAs evaluate and return to the students with feedback the students are expected to incorporate into future assignments).

To determine if the program led to improved student technical writing, I used summative assessment, which Garrison and Ehringhaus [33] define as “a means to gauge, at a particular point in time, student learning relative to content standards.” They maintain that the purpose of summative assessment is “to help evaluate the effectiveness of programs (emphasis mine), school improvement goals, alignment of curriculum, or student placement in specific programs.”

### Program Structure

While staff and faculty instructors oversee lectures in these lab courses, graduate teaching assistants (GTAs) from within the department, many of whom speak English as a second language, teach the labs and evaluate the reports. Previously, the GTAs received no training in evaluating student writing. They were required at some point in their academic career to take ED 5100 College Teaching, which taught basic course management skills such as developing a syllabus, leading discussion, and interacting with students – all of which are valuable skills, but not exactly what the lab GTAs needed to effectively evaluate writing. Because of this lack of training, undergraduate students often complained they received inadequate feedback on their lab reports, that grading was inconsistent between GTAs, and that they learned little or nothing about technical writing from completing these reports.

This project officially began in summer 2012 with one comprehensive goal – to help the GTAs effectively evaluate student writing in their lab courses. Knowing that a faculty member in the university’s Department of Physics had developed a one-day training session for GTAs involved with the first-year physics sequence required of all engineering students, my first step was to meet with him to learn the structure and results of his efforts. While the actual structure was not going to be applicable to our needs (the Physics assignments required much less writing and, therefore, less feedback), the program was successful in reducing the failure rate by a significant amount thanks to a GTA handbook, common rubric, and grade norming sessions.

Once the department committed to providing its own training, the author established a team to help develop sub-goals, lab report guidelines, and rubrics to aid evaluation, and appropriate content for each session. The team included two lead course GTAs and six faculty (five lab instructors and one course coordinator). The team developed three sub-goals: 1) improve consistency of grading from TA to TA, 2) improve quality of GTA feedback on lab reports to facilitate learning, and 3) improve the quality of student technical writing, to be measured through a rigorous assessment process. During several meetings that summer, the team discussed what students needed to learn in the labs, both in terms of course-specific knowledge

and communication skills. These conversations led to a better understanding of what students needed to master in each course as they advanced through the curriculum, which then provided insight into ways the GTAs could help their students achieve these learning goals. The team also developed a comprehensive lab report guidelines document for use in all three courses. The guidelines provided information on formatting, composing the type of content expected in each section of the report, and creating figures and tables, as well as other technical writing tips. The team also created a rubric, mapped to the guidelines, to help bring consistency to grading. While just one set of guidelines applied for all the labs, the rubric could be customized to reflect the requirements of a particular lab. This information was combined with best practices in WAC faculty training to create the five-session program structure described below. The training focused on:

- the importance of teaching technical communication skills in these undergraduate classes
- their role as educators in the department (this aspect is often overlooked in the ME-EM, where TAs do not act as instructors in lower division courses)
- how and why the rubrics and guidelines were developed and how to use them as instructional and evaluation tools
- the types of feedback that are most helpful to students and that encourage critical thinking about their writing
- ways to provide the most effective feedback in the least amount of time

To facilitate discussion of what it means to provide effective feedback on student writing, we use Beth Hedengren's book *A TA's Guide to Teaching Writing in All Disciplines* [34] as the main text. The first three training sessions stressed concepts we wanted the students to grasp – language clarity, the function of each section of the lab report, appropriate use of scientific terminology, analysis of data, formatting that data into accurate figures and tables, and, finally, professional presentation of the content, which includes grammar, punctuation, and sentence structure. The GTAs were advised not to correct local issues; rather they are to direct the students to proofread more carefully and/or seek help from resources such as the university's Multiliteracies Center. However, they were instructed to deduct a small number of points for such errors. We then practiced using the guidelines and rubrics to provide feedback on a sample lab report and we discuss their responses as a group, highlighting wording that is particularly effective in guiding the student towards improved clarity.

The goal of the fourth session was to familiarize GTAs with some of the keys issues they would face administratively. This session evolved over time, with the content sometimes being included in the third session if it was particularly difficult to schedule all of the GTAs at one time. We also reviewed the department and university procedure on handling suspected cases of plagiarism, which has long been an issue in the MEEM 3220 Energy Lab.

The final session was usually held at the end of the semester and included reflection on what worked during the semester and what we as a department could do to improve the tools and courses for both the GTAs and the students. This session helped to close the loop in the training

by encouraging the GTAs to reflect on whether they were successfully performing the tasks explained to them in the beginning of the training.

### The GTA Perspective on the Training

The author's objective in making the GTAs partners in this research was to make explicit the many "unwritten" conventions, biases, and power structures in the department and the university and thus provides an opportunity to acknowledge and address them. The GTA perspective tells a piece of the narrative of communication instruction in the ME-EM undergraduate degree program, as opposed to "claiming to see from their positions" [35]. For example, interviews with the international GTAs in the first year of the training revealed that they were caught in two divergent conflicts that were either never discussed during orientations/training or were addressed only in passing. The first conflict occurred with their graduate advisor, who dictates their research and their timeline to graduation. A few of the GTAs said their advisors had directed them to spend as little time as possible on their teaching assignment (which financially supported their education) so they could focus their time on research. This put the GTAs in a difficult position because they were essentially serving two "masters," their course instructor and students and their advisor. The author attempted to resolve this issue by reporting it to the department graduate program director who said he would address it on an individual basis. The problem is that many of the international GTAs are not comfortable with expressing a concern to, or about, someone in a position of authority.

A second conflict occurred with their students and was based on the fear that students would evaluate them poorly at the end of the semester or complain to the faculty member in charge of the course if they do not receive a high grade. Because these GTAs were often already self-conscious about their English language skills, they may have avoided the issue of grades by assigning no grades lower than a B for lab reports. Having a rubric went a long way toward clarifying and expediting grading, especially for those more experienced GTAs who had taught the labs without having a rubric for at least a few semesters and could make a comparison. One GTA said the rubric also "added clarity to grading" for both student and GTAs, eliminating some of the conflicts that could arise from different interpretations of instructions. That is not to say there were no conflicts over interpretation, though, which is why we instituted grade norming sessions in fall 2013. These sessions eliminated some differentiation in interpretation, but did not completely solve the problem. Broad [36] points out that a person's evaluation of a student product may depend heavily on the context of the situation. For example, a GTA will likely grade differently when faced with real students and the consequences of assigning a poor grade as opposed to "practice" grading where the GTA may grade more harshly to impress the instructor (or me) and not have to deal with a student arguing about a grade. A few of the GTAs admitted that they assigned points generously compared to others because they were afraid to have confrontations with students because they were not proficient enough to make their case in English.

### Feedback Regarding the Training Itself



Only one GTA expressed outright hostility to being required to take the training. A PhD student who had earned his bachelor's and master's degrees more than a decade earlier at this university, Greg felt the students should be required to take a technical communication course, as he had, and that it was not the place of engineering faculty or GTAs to teach writing. Conversely, even experienced GTAs found the training helpful in improving their pedagogy. "Anwar" had been a GTA for a few years prior to participating in the first training series in fall 2012. He was able to improve his feedback to students by asking questions to encourage students to think about why their statements were incorrect or how to deepen their understanding of a concept. An added bonus in his view was that the training "made me analyze my own writing and consider the reader more when I pursue writing tasks as a graduate student."

### Undergraduate Student Perspective on the Program

In this section, I discuss the results of the seven-question survey given in the MEEM 3220 Energy Lab and MEEM 3000 Mechanical Engineering Lab courses. MEEM 3220 was typically completed in the third year of the BSME program, while MEEM 3000 was usually completed in the fourth year. The survey was not given in MEEM 2500 Industrial Design and Manufacturing, the other required lab course included in this training program. At the close of the fall 2012 semester, the teaching team was more interested in capturing the perceptions of students who might see a difference in their own and their GTAs performance with the introduction of the lab report guidelines, rubric, and training for their GTA compared to their experience in MEEM 2500. When we realized the survey would be a useful assessment tool in the long term, we chose to continue with just those two courses for consistency. Participation in the survey was voluntary so the response rate varies from a high of nearly 95 percent in the fall 2012 semester of MEEM 3000 to a low of 73.5 percent in a semester of MEEM 3220.

The survey asked about the amount and perceived quality of the written and verbal feedback the GTAs were providing to them as well as the students' perceptions of feedback on the tools and whether those tools helped their learning. Responses to the seven questions were categorized into between thirteen and fifteen themes unique to each question. These themes were then grouped into broader categories to facilitate discussion and analysis. Questions one through four and question six addressed the lab report guidelines and corresponding rubric. The vast majority of students found both the guidelines and rubrics useful in understanding the requirements of the lab reports. However, there were some notable differences between the two courses. The root of these differences is related to the unique structure of MEEM 3000. While MEEM 3220 is structured like a typical course, with one GTA assigned to a section for an entire semester, MEEM 3000 is divided into three subject areas – vibrations, solid mechanics, and thermal sciences. One GTA is assigned to each of these subject areas, which means students have three different GTAs evaluating their work throughout the semester. Thus, there has always been an issue with consistency in grading between the GTAs. When the teaching team created the lab report guidelines and rubric and instituted grade-norming sessions, the hope was that more consistency would result. Since the survey only covered students whose GTAs had been through the training, we cannot know if the new tools and grade-norming sessions accomplished this goal.

The tools developed by the teaching team were seen as the first step in helping students better understand the lab report genre and guiding GTAs in providing feedback that would further student learning. Questions five and seven explore student perceptions of that feedback and their suggestions for improving it. One message came through clearly – most students understood that writing is an iterative process, even in a lab course where there were no “drafts” and they appreciated when GTAs take the time to provide detailed feedback to help them improve future reports.

### Summative Assessment

To gain some insight into whether the program actually improved student technical writing, I used summative assessment, with a team of impartial evaluators who completed a training/norming session using the University Student Learning Goal for Written Communication analytic rubric. The assessors applied the rubric to “blind” reviews of portions of Senior Capstone Design final reports from the spring 2012 semester and the spring 2015 semester. These timeframes were chosen because the GTA training program began in fall 2012, so students completing Senior Design this spring have taken all their required lab courses with trained GTAs. The sections (subsections in parentheses) reviewed were:

- Executive Summary
- Detail Design and Supporting Analysis (Preliminary /Feasibility Engineering, Design Failure Modes and Effects Analysis, Mathematical Modeling and Analysis, Safety considerations, Material Selection, Manufacturability and Assembly Considerations, Production Unit-Cost Analysis, Additional Considerations such as environmental sustainability, reliability, maintainability and serviceability, aesthetics, human factors, product liability, and ethical issues)
- Final Evaluation and Verification (Manufacture and Assembly, Testing and Refinement, Project/Development Cost)
- Conclusions and Recommendations

These sections were chosen for assessment because these sections require students to apply their:

- 1) Knowledge of how to recognize the audience for a particular communication, determine the needs of that audience, and successfully address those needs;
- 2) Ability to present test results through graphics and text;
- 3) Ability to analyze and interpret data; and
- 4) Ability to develop reasonable conclusions and recommendations based on their interpretation.

These are all skills emphasized in the lab courses and assessed through the resulting lab reports. Therefore, this assessment provides some insight into whether, and how well, the students transferred their knowledge of these four areas from their efforts in the lab courses to their work in Senior Capstone Design (SCD), a four-credit, two-course sequence usually completed in the final two semesters of a student’s BSME program. The final report, due during finals week of the second semester, is a cumulative document that teams begin in the first semester and scaffolding upon through a series of five reports with revisions based on feedback from the

program advisors and additions as they progress through the design process. The five reports each have templates with language explaining what is required in each section. Neither the templates nor the course instructor changed between spring 2012 and spring 2015.

### Structure of the Assessment

This assessment was completed following the close of the spring 2015 semester. I recruited five ME-EM graduate students by seeking recommendations from departmental faculty. A diverse group, all of the graduate students were proficient in reading, writing, and speaking English. None had any prior experience with the lab courses that were the subject of this research nor with the Senior Capstone Design program. After a norming exercise using the University Learning Written Communication Rubric, developed by the American Association of Colleges and Universities, each assessor was given seven or eight reports to evaluate. Each report was coded according to the semester of origin, with all identifying information removed, and then evaluated by two different assessors. Assessors were allowed to ask clarifying questions during the evaluation, but not to discuss their evaluations with each other until after the assessment was complete.

### Assessment Results

The rubric contains five criteria on which to evaluate student writing: context and purpose for writing, organizations and conventions, content development, sources and evidence, and control of syntax and mechanics. An evaluator could select from one of four categories in assessing a criterion – Beginning 1, Developing 2, Proficient 3, or Exemplary 4. The goal of the university's First Year Composition program is to have all students who complete the FYC course producing written work that is at least at the Developing stage. The university has indicated it expects degree programs to provide at least one writing-intensive disciplinary course that helps its students achieve at least Proficient level performance upon completion of their degree requirements. Table 1 shows the results of the summative assessment in the five categories of the university's written communication learning goal rubric. The number under each category indicates the number of reports scoring at the Proficient 3 level or higher for each semester.

Table 1 Senior Design Final Report Summative Assessment Number of reports assessed at Proficient or higher level N=18 for each semester					
Semester	Context and Purpose for Writing	Organization and Conventions	Content Development	Sources and Evidence	Control Syntax and Mechanics
Spring 2012	15	13	8	6	15
Spring 2015	14	17	13	12	17

Moderate improvement was seen in the Organization and Conventions category, while more substantial improvement was seen in both Content Development and Sources and Evidence. Because the GTAs were instructed not emphasize grammar and punctuation issues in their evaluation, no improvement was expected in the Control Syntax and Mechanics category. A gain of two reports scoring at least at the proficient level is not seen as statistically significant.

No improvement was shown in Context and Purpose for Writing. This makes sense considering that the lab reports did not provide a meaningful opportunity to write for a particular audience in a particular context beyond the laboratory.

While this assessment demonstrates some improvement in the quality of SCD final reports over a period of three years, I hesitate to place too much emphasis on these results. Although this type of summative assessment may meet the criteria for reliability since the rubric has been vetted by a committee of faculty, I wonder if the final reports are a valid measure of a student's ability to communicate well as an engineer. My main concern is that most of the lab reports evaluated by the GTAs were written by groups of two to three students and the SCD reports were written by groups of four to six students. In most cases, the best writer in the SCD group was responsible for compiling and editing the final report so whose writing is really being assessed?

Unfortunately, most writing in the former BSME program (a new curriculum was established in fall 2014) happened in a group setting, so my options were limited. The new curriculum includes more emphasis on individual writing in the ME Practice courses, especially the first two courses in the sequence, when students are beginning to develop technical communication skills.

## Conclusions

In interviews following the training, the majority of GTAs said the training helped them provide higher quality feedback and improve their own writing because they were more aware of issues such as audience and logical flow. The survey showed the undergraduate students found the set of lab report guidelines for all three courses and corresponding detailed rubric helped them better understand report requirements and expectations. The survey also showed that there was still some inconsistency in grading from GTA to GTA in one course in particular, but that many GTAs were providing detailed feedback that helped them learn. The summative assessment showed improvement in four of five categories measured in the university's written communication learning goal rubric. Most importantly, feedback from GTAs and undergraduate students played a valuable role in a curriculum redesign that occurred in parallel with the implementation of this training program.

## Developing Similar Training Programs Elsewhere

While the university where this research was situated has not had an active WAC program for more than twenty years, such a training program could be adapted at universities that do have campus-wide writing initiatives. Such a program could also be initiated through graduate schools with existing training programs in place, e.g. Preparing Future Faculty, Centers for Teaching and Learning, and colleges of engineering. For example, this university's Center for Teaching and Learning (CTL) provides short-course sessions on a range of topics for GTAs and new faculty. Based on my work in the ME-EM department, I created an abbreviated version of the training for the CTL and delivered the session twice with a CTL staff member in attendance. That staff member now teaches the session. Additionally, colleges of engineering with established technical communication programs might find this training useful.

As the example of this mechanical engineering department demonstrates, though, such established infrastructure is not required for such a training program to work. It does, however,

require a commitment to teaching the communication conventions of a particular field within the disciplinary courses and/or a collaborative partnership with faculty from degree programs such as humanities, technical communication, composition, or English to help provide such instruction.

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