2016

Extending Writing in the Disciplines (WID) to Train Mechanical Engineering GTAs to Evaluate Student Writing

Nancy Barr
Michigan Technological University, nbbarr@mtu.edu

EXTENDING WRITING IN THE DISCIPLINES (WID) TO TRAIN MECHANICAL ENGINEERING GTAS TO EVALUATE STUDENT WRITING

By

Nancy B. Barr

A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

In Rhetoric, Theory and Culture

MICHIGAN TECHNOLOGICAL UNIVERSITY

2016

This dissertation has been approved in partial fulfillment of the requirements for the Degree of DOCTOR OF PHILOSOPHY in Rhetoric, Theory and Culture.

Department of Humanities

Dissertation Advisor: *Robert R. Johnson*

Committee Member: *M. Ann Brady*

Committee Member: *Karla Kitalong*

Committee Member: *James D. De Clerck*

Department Chair: *Ronald Strickland*

Table of Contents

Table of Figures

Preface

This dissertation research began with a collaboration of faculty and graduate teaching assistants from the Department of Mechanical Engineering-Engineering Mechanics who developed a set of lab report guidelines (Appendix B) and a corresponding rubric (Appendix C), both described in Chapter 2. The collaborators and their contributions were:

- John Armstead (then-PhD student): Provided input on how GTAs viewed the lab courses and the format for the guidelines. Contributed to wording of the rubric.
- Nancy Barr, MS (technical communications advisor): Created team of faculty, staff, and graduate students; developed/delivered training, and analyzed/interpreted survey and assessment data.
- Jason Blough, PhD (associate professor): Provided input into section language for the lab report guidelines and wording of the rubric. Course coordinator for MEEM 3000 Mechanical Engineering Lab.
- James De Clerck, PhD (professor of practice): Provided template for the rubric and input into section language for the lab report guidelines. He taught the dynamics portion of MEEM 3000 Mechanical Engineering Lab.
- Timothy Jenkins (then-PhD student): Provided input on how GTAs viewed the lab courses and students wrote in MEEM 2500 Integrated Design and Manufacturing.
- L. Brad King, PhD (professor): Provided input into section language for the lab report guidelines and wording of the rubric. He taught the thermal sciences portion of MEEM 3000 Mechanical Engineering Lab.
- Mike LaCourt (research engineer): Provided input into section language for the lab report guidelines and wording of the rubric. He coordinated the lab portion of MEEM 2500 Integrated Design and Manufacturing.
- Charles Margraves, PhD (principal lecturer): Provided input into section language for the lab report guidelines and wording of the rubric. Course intructor for MEEM 3220 Energy Lab.
- Ibrahim Miskioglu, PhD (associate professor): Provided input into section language for the lab report guidelines and wording of the rubric. He taught the solid mechanics portion of MEEM 3000 Mechanical Engineering Lab.

Additionally, the University Learning Goal 5 rubric for Written Communication was used in assessing student writing. Permission to reprint this rubric in Appendix F of this dissertation was granted by Dr. David Reed, Vice President for Research at Michigan Technological University, via a letter dated February 2, 2016. The letter is attached as Appendix G.

Finally, this project received a Human Subject Research exemption from the university's Institutional Review Board (Internal Number: M0936).

Acknowledgements

This project would not have been possible without the many people mentioned in the Preface. Additionally, I am grateful for the data entry skills provided by ME-EM undergraduate student Joseph Szczap.

My advisor, Dr. Robert Johnson, and committee members Dr. M. Ann Brady and Dr. Karla Kitalong have guided me through the process of processing mounds of data and converting it all to something that I hope is meaningful to the academic community. Dr. Victoria Bergvall, while not a member of my committee, helped me find a research method that would make categorizing the student surveys much more productive.

I'd also like to thank Dr. William Predebon, ME-EM department chair, for his continued support of the GTA training program and the broader effort to embed technical communication instruction at both the undergraduate and graduate levels.

I also owe a debt of gratitude to Runner's World *magazine and Jeff Galloway, the guru of newbie runners across the country. It's no coincidence that I started running around the same time that I began work in earnest on my PhD. Whenever I was feeling confused or conflicted about where to go with my work, running a few miles would help me focus, sort out my thoughts, and plan what I needed to do/write next.*

Finally, I would not have been able to complete either of my graduate degrees without the love and support of my partner in life, Tom, who boosted my confidence when it was lagging and understood when I needed to focus on "school."

This dissertation is dedicated to my parents, who, while they did not live to see me earn a PhD, valued books and learning despite their own lack of formal education: Harry Barr (1939-2014) and Patricia Barr (1931-1981).

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 dissertation 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 to develop technical writing skills without a concerted effort by faculty to incorporate such writing into their courses. One underutilized path for BSME students to strengthen those skills is the often required sequence of laboratory courses, where students typically write several lab reports, 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 practices to help students improve their technical communication skills. 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 (Yorke, 2003, pp. 478-479). Such assessment can be informal such as feedback on drafts, immediate responses to student questions or presentations in class, or formal such as graded work such as lab reports on which GTAs provide feedback that the students are expected to incorporate into future assignments.

This dissertation details a comprehensive research study of a GTA training program implemented in a large mechanical engineering department at a small Midwestern public research university. Situated within the fields of Writing Across the Curriculum/Writing in the Disciplines and technical communication, 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" (Winsor, 1996), using 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:

1) Qualitative methods including interviews and roundtable discussion helped gauge GTA needs and performance. Additionally, an open-ended survey of students two of the labs aided in assessing the usefulness of instructional tools developed to assist GTAs and students as well as the effectiveness of their GTA's feedback.
2) A quantitative method, summative assessment, was used to evaluate Senior Capstone Design final reports completed prior to when the GTA training program was implemented and similar reports completed three years later.

In follow-up interviews, 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 recognizing the needs of the audience and developing a logical flow of ideas to meet those needs. 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 course content and technical writing. The summative assessment showed improvement in four of five categories measured in the university's written communication learning goal rubric: Organization and Conventions, Content Development, Sources and Evidence, and Control Syntax and Mechanics. No improvement was shown in Context and Purpose for Writing. Feedback from GTAs and undergraduate students played an important role in a curriculum redesign that occurred in parallel with the implementation of this training program.

This research is relevant to undergraduate engineering programs seeking to improve the communication skills of their undergraduate students as well as 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 address technical writing skills in all its undergraduate students through existing required courses.

Chapter One: Interdisciplinarity in Action

In the nearly five decades since its inception on U.S. campuses, the Writing Across the Curriculum movement has evolved as technology has altered methods and modes of instruction and faculty needs have changed. In STEM (Science, Technology, Engineering, and Math) fields, two trends have converged to require writing program administrators to think creatively to ensure undergraduate students receive effective communication instruction that will help them succeed in their careers. These trends–increasing pressure on faculty to develop and sustain active research programs and an increasing proportion of faculty and graduate students who speak English as a second or third language–translate to a need for flexibility in writing programs. Such flexibility helps faculty who have less time to focus on classroom initiatives and rely more on GTAs to deliver content and evaluate student work.

Despite these trends, research on training and effectiveness of STEM GTAs in teaching and evaluating technical writing is lacking. This dissertation presents research about a program developed to help GTAs more effectively evaluate student writing and the results and implications of that program. One of those implications is that not only is it possible to incorporate STEM GTAs into WAC initiatives, but such initiatives can be quite successful. In this first chapter, I review the literature on technical communication, the interdisciplinary nature of this work, and GTA training. I also briefly discuss my research question, methodology, and methods. Finally, I describe the structure of the dissertation.

Technical Communication in Engineering–A Contested Space

Technical communication is a discipline of its own, separate from English, composition, and rhetoric, although it does have strong connections to each of those fields. Like composition, it is also a relatively new discipline. While it can trace its history back to ancient times, formal technical writing instruction in the U.S. began with the rise of engineering as an academic discipline following the Civil War (Connors, 1982/2004). As humanities courses in language and classical studies were gradually replaced by "technical" courses, it became apparent to the engineering community around the turn of the 20th century that engineering students needed instruction in writing "coherent engineering reports" (p. 79). Colleges of engineering, such as at the University of Michigan, developed their own "in-house" courses focused solely on technical writing.[1] The nature of these courses was the subject of much debate–Connors framed it as literature vs. vocationalism (p. 83). While the more positivistic vocational approach dominated for most of the century, a more humanistic approach is more commonplace in the 21st century, although technical communication is still very much a contested space as I will show in the next section.

Who Should Teach What to Whom?

As engineering education matured throughout the latter half of the 19th century and first half of the 20th century, technical communication emerged as a distinct field, albeit one whose very existence was tolerated by some academics as a necessary evil and

[1] U-M's program is still in existence and many other prominent engineering schools have formal Technical Communication Programs, including University of Iowa, University of Wisconsin-Madison, Stanford University, and University of Southern California. I used the latter three programs as models for the technical communication efforts in the MTU ME-EM department.

reviled by others who saw it as a corruption of the more “noble” field of English. While engineering faculty debated what types of writing courses would be most beneficial for their students–composition and literature or something more practical–faculty from the English department had little to say on the issue (Kynell-Hunt, 19992004, p. 13). Instead, many faculty in humanities departments and schools fought against the inclusion engineering and other such “practical” disciplines in the university curriculum, arguing that a university education was not about utility, but rather the gaining of knowledge through a broad liberal education that could applied to any field upon graduation (Whitburn, 2000, pp. 176-177). This philosophy led many in the humanities to view technical communication instruction, along with first year composition, as beneath them, something that, if it had to be taught through their department, should be in the purview of graduate students. Literature, and its critique, was the highest calling of English faculty, the teaching of basic and professional writing the lowest calling. It was not until the 1950s that bachelor’s degree programs in technical communication emerged and later still for masters and PhD programs.[2] It is also interesting to note that in much of the literature on writing in engineering education in recent years, the term *technical communication* rarely figures in the title. Instead, key words tend to include writing and presentation skills. The debate about technical communication does not end with whether to teach it, who should teach it, or even what the subject should be called, though.

---

[2] In the interest of full disclosure, it should be noted that Michigan Tech revised its master’s and PhD programs in rhetoric and technical communication in 2013, changing both degree titles to Rhetoric, Theory, and Culture.

The argument over the best approach for instructors of technical communication to take in their courses continues to this day and is perhaps best expressed in the debate between Robert Johnson and Patrick Moore about whether a rhetorical (Carolyn Miller would call it "humanistic" [1979]) or instrumental approach is most effective and appropriate. Johnson makes the case for "complicating technology" by going beyond simply describing technology in reports and instructions to questioning the need for such technology and considering the long-term consequences of that technology (1998/2004). He argues that recognizing and embracing interdisciplinarity through an understanding of the history of technology, philosophy of technology, ethics, and rhetoric as they relate to why and how technology is used moves technical communicators beyond the role of "mere scribe" (p. 25).

Moore counters the call for a rhetorical approach by advocating for an instrumentalist approach, explicitly addressing six "myths" about such discourse that devalue it as a "tool of capitalist oppression," among other things (1999/2004, p. 56). He draws on Toulmin, Preike, and Janik et al's definition that instrumental discourse encompasses "those utterances that are supposed to achieve their purpose directly, as they stand, without the need to produce any additional 'reasons' or 'supporting arguments'" (1984, p.5). He also cites Beale's expectation of the purpose of such discourse as "the governance, guidance, control, or execution of human activities" (1987, p. 94).

There are, of course, others in the field working to bridge the gap between these two divergent approaches, Knievel's work being just one example (2006). This debate is relevant to the work presented in this dissertation because, as I will explain in future chapters, for engineers to *present* their work ethically, they must first understand the ethical implications of that work. If the frameworks to think critically about their roles as engineers are not presented in their disciplinary technical communication experiences, where are these experiences to be had? Thus, interdisciplinarity plays an important part in this project.

Interdisciplinarity in Action

Charles Bazerman, known for his studies in science writing, exemplifies the concept of interdisciplinarity, crossing boundaries to develop a full understanding of how scientific knowledge makes it into print. In an article tracing his intellectual history as an interdisciplinarian, he states:

> "Writing is a complex activity, influencing the orientations and activities of minds located in historical, social, and physical worlds; through the creation, distribution, and reception of signs through various technologies and organizational systems; and as a consequence establishing an archive of thought, action, and events for further social use" (2011, p. 8).

As one might surmise from this introductory chapter, this project is highly interdisciplinary in its foundations, methods, and, I hope, impact. Such an approach was not intentional on my part; rather it was an organic outgrowth of the needs of the department's many constituencies. Students needed opportunities to develop and practice communication skills within their discipline, which meant drawing from the fields of technical communication, writing studies, and rhetoric. Faculty and GTAs needed to know how to incorporate more communication instruction into their courses and evaluate the students' work, which required looking at the fields of Writing Across the Curriculum and pedagogical theory. Since so many of the department's GTAs speak English as a second language, I needed to understand the basics of ESL writing and learning theories. Assessing the effectiveness of the program required a multipronged approach "borrowing"[3] from traditional writing assessment practices, qualitative research methods (social sciences), and standpoint theory (feminist studies). Figure 1 displays a graphical representation of the way in which I view this project as borrowing from, and contributing to, a range of disciplines.

Figure 1 Interdisciplinary focus of GTA Training Program

[3] Klein devotes a chapter to the concept of borrowing from multiple disciplines to address a complex issue as a form of interdisciplinarity in her 1990 monograph (pp. 85-94).

This research project was made possible through my efforts to build a bridge from the Department of Mechanical Engineering-Engineering Mechanics to the Department of Humanities, whereby scholars on both ends of campus (literally and figuratively at Michigan Tech) could exchange ideas, enhance existing programs, and develop new strategies for addressing unmet needs. Klein uses the metaphor of bridge building, first identified by the Nuffield Foundation, to describe collaborations between "complete and firm disciplines", which frequently have an applied orientation (1996, p. 10). This bridge building has had at least three effects in recent years:

1) A collaboration between the First Year Composition program through then-PhD student Kevin Cassell and ME-EM faculty member James De Clerck to better understand how writing is used in the ME discipline,
2) A more effective use of the Multiliteracies Center on the part of ME-EM faculty and students thanks to improved communication about the center's services, and
3) A better understanding of the role of general education in developing students' communication and critical thinking skills on the part of ME-EM faculty involved in this research project.

Because convention requires all academic research to have a home base of sorts, this work falls under the broad, nebulous field of Writing in the Disciplines (WID), which by its very nature is exemplary of the concept of interdisciplinarity. Bazerman's article quoted earlier addresses writing studies specifically, but his view regarding the ways in which interdisciplinarity functions is just as true of WID. He states, "Interdisciplinary work is likely to shake up assumptions, concepts, methods, and inquiries one brings from a home discipline" (2011, p. 18). With this dissertation, I want to dispel the assumption that ESL GTAs cannot effectively evaluate student writing because this assumption is based on false perceptions. I also want the engineering education community to have a model of how to make the most of existing resources to develop the communication skills bachelor's degree-seeking students will need to succeed as engineers and citizens. Finally, my hope is that this work will not only open up more avenues of inquiry between the humanities and engineering education in terms of teaching and research methodology, but also spark conversations about other ways we can enrich each other's work for the benefit of our disciplines and our students.

ME-EM Technical Communication Program Goals

The goals of the ME-EM's technical communication efforts is to bring students into the community of mechanical engineering by teaching them how to communicate their knowledge and ideas using the appropriate terminology in an ethical manner in the genres common to the profession, e.g. presentations, test reports, and design reports. This effort is rooted in the fields of Aristotelian rhetoric, with a focus on audience, and technical communication, with a focus on usability. It is not an effort build a set of skills in "subduing language so that it most accurately and directly transmits reality" (Miller, 1979/2004, p. 16). Instead, the faculty try to teach technical writing and presentation skills in a way that encourages students to see their role as engineers as extending beyond the wall of a design studio, test track, or laboratory and affecting the lives of people who use what they have engineered. Students must be able to recognize, understand, and address the needs of the varied audiences their work will effect. For example, we encourage students to use metaphors to explain complex concepts, to consider document design as an important part of the composition process, and, where appropriate, to replace convoluted blocks of text with well-designed graphics.

Pedagogical Approach

Much of the style, content, and structure of the instruction falls under the category of social constructionist pedagogy, one of the four socially oriented pedagogies common in technical communication programs, as detailed by Thralls and Byler (1993/2004). This approach emphasizes the role communities play in shaping discourses p. 111). The other three pedagogies are:

1) Ideologic, which encourages critiquing existing discourse conventions and power structures;
2) Social cognitive, which uses the concept of discourse communities but also views the initiation of students into these communities as a cognitive process that requires self-reflection to avoid falling into rigid norms without question; and
3) Paralogic hermeneutic, which encourages "writing courses [to] aim to reveal to students the external, socially interpretive, and unsystematic nature of communicative action" (p. 121).

Social constructionist pedagogy classroom practices include discussion about the document and language used by practicing engineers and an emphasis on collaboration through teams such as Senior Capstone Design and lab groups (pp. 112-113).

One concern with a social constructionist approach is the lack of opportunity to critique the norms of the mechanical engineering discourse community such as how language can privilege people of a certain class, race, or gender. The ME-EM department is under pressure from ABET, the department's External Advisory Board[4], and Senior Capstone Design project sponsors to emphasize the practical aspect of reports and presentations, i.e. get to the point, do not "editorialize," just tell the audience what it needs to know to act on your information. As this research study unfolded and I learned more about the student, faculty, and industry perspectives on disciplinary writing, I began to question the value of the lab report genre and its prominence in the curriculum. While I address how I turned this questioning into action as the department revised the curriculum, I want to make clear at the beginning of this dissertation that I do not view the lab report as an ideal, or even a particularly effective means of teaching engineering writing conventions. I address this topic in more detail in Chapter Two.

Evolution of GTA Training

As with many aspects of the modern university system, the literature on graduate teaching assistants (GTAs) and their training begins with a few mentions in the latter half of the nineteenth century, as the number of public universities grew to reach more students and they developed more specialized disciplines. However, the widespread use of graduate students as teachers did not begin until the post-World War II era increase in college enrollment (Van Note Chism, 1998, p. 2). Van Note Chism breaks the history of GTA training into four distinct but overlapping phases: "Nothing to Say," "Private Conversations," "Can We Talk," and "Extending the Conversation." This first phase refers to the complete lack of discussion on preparing graduate students for the classroom

[4] As part of its accreditation requirements, ABET insists that each engineering department within a university have a board of external advisors from industry, academia, or research entities who review the department's degree program(s) to ensure quality and relevance to the needs of such external stakeholders.

and lasts until about 1960 (although some universities may still provide little or no training for their GTAs in 2015). Instead, the most prevalent attitude toward faculty development was that good teachers were born, not made, meaning no preparation was needed, i.e. “here’s the textbook, there’s your class, good luck.” Van Note Chism uses 1960 as a division because there is little mention of GTA preparation in the literature prior to this time. The next three phases demonstrate a progression toward the formal, multi-faceted training programs we see today, especially in departments where graduate students hold the title of instructor of record as opposed to teaching assistant.

The second phase is dubbed “private conversations” because the discussion of GTA training generally took place at the department or academic program level rather than at the university or disciplinary levels and any insight gained from such training was generally only reported in disciplinary publications, if at all. Those publications tended to be descriptive–details about a particular program–or prescriptive–arguments for doing more for GTAs than was the current standard. There were exceptions, though, as the Carnegie Foundation and universities like Stanford and Northwestern began to place more emphasis on faculty development in general and GTA development in particular (Van Note Chism, p. 3-4). The next phase, lasting for about twenty years, progressed into a phase of broader interest and open discussion, characterized by the first national conference on GTA issues in 1986. Initially, this phase focused on policy issues, as more large institutions realized that many of their undergraduate courses were being taught by graduate students and that these GTAs needed better preparation and, some argued, better treatment overall. Additionally, it was during this third phase that higher education began to take notice of the special needs of international GTAs and "the intolerance of the U.S. undergraduate" toward this population (p. 5).

The most recent phase "extended the conversation" as politicians raised concerns about GTA training, especially for those who spoke English as a second language, and introduced legislation at the state level for public institutions. Universities developed a broader definition of faculty development to include GTAs. An example of this effort is the Preparing Future Faculty (PFF) initiative funded by the Pew Charitable Trusts and coordinated by the American Association of Colleges and Universities and the Council of Graduate Schools. Originally employed at seventeen universities, the program, which continues to this day, focuses on extensive training, documentation via teaching portfolios, and mentorship by experienced faculty.

Currently, GTA training runs the gamut from non-existent (rare) to PFF-type programs (less rare, but still not the norm because of their resource-intensive nature), with most efforts falling somewhere in between. At a minimum, most programs provide some instruction in privacy rules such as FERPA, using content management systems such as Canvas or Blackboard, and resources available on campus such as Centers for Teaching and Learning and writing centers. Beyond the basics, some universities offer pedagogy courses (MTU's ED 0510 GTA Training is an example, which is taught through the Center for Teaching and Learning) and departments often provide their own training specific to the needs of their undergraduate program (MTU's Department of Humanities GTI training course sequences for first year composition and technical communication are examples).

GTAs and Writing in Engineering

In the last fifty years, the literature on GTA training has grown from non-existent to rich, with the need for such training still a topic of discussion (Ambrose and Bridges, 2010; Feldon et al., 2011; Marincovich, et al., 1998; Nyquist, 1991). 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" (Bandura, 1997, p. 3), has also been the subject of research (Prieto and Meyers, 1999; Park, 2004). Additional research has been done in training GTAs to teach writing in composition courses (Morgan, 2002; Spooner and O'Donnell, 1987;Taylor and Holberg, 1999) and exploring the special needs of Chinese GTAs teaching composition to native English-speaking students (Liu, 2005). Rodrigue (2012) traces the evolution of training GTAs in teaching 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 (Russell, 2002, pp. 288-289). Since then, programs at Cornell University, the University of Minnesota-Minneapolis, and other institutions 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 (Rodrigue, 2012).

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 (Lambert and Tice, 1993). To put an even finer point on the issue, development of training in responding to student writing in the disciplines to improve GTA self-efficacy in terms of providing effective feedback to students has not been explored at all. When training is provided, 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 (Rodrigue, 2012).

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 (2007) studied the evaluation practices of mechanical engineering GTAs, 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 be rooted in the once-prevalent belief by many engineering faculty and their students that writing instruction should take place in general education courses, not disciplinary courses and that it should focus on mechanics of writing, rather than rhetorical features such as audience and context, as shown in the following sections.

Incorporating GTAs into Disciplinary Writing Instruction

The literature on engineering communication is replete with references to negative attitudes toward writing on the part of students and the teaching of writing in the disciplines on the part of faculty. Bahls (2012), in a book directed at faculty in quantitative disciplines, describes four questions or concerns students in STEM disciplines typically have when an instructor incorporates writing into the course (p. xi):

- Why do I have to write in this class? Aren't I just supposed to find the right answer?
- You're not an English teacher. What do you know about teaching writing?
- I'm not used to writing like this. What I supposed to say in this paper?
- I'm not here to learn writing. I'm here to solve problems.

He attributes this resistance to two factors prevalent in quantitative disciplines. The first is teaching methods and textbooks that obscure the process of how to arrive at the correct answer so students find the writing process alien (p. 15). The second factor is that science writing often obscures agency, with its reliance on passive voice in technical reports and journal articles (p. 16). The scientist is absent from the discovery; the result is what matters, making it difficult for students to see the value of documenting the journey toward that discovery. This attitude carries into the job where engineers see "documenting [as] an especially onerous chore (Tenopir and King, 2004, p. 95). Winsor notes, however, that students who participate in internships develop a positive attitude toward writing instruction once they realize its importance as a practicing engineer (1996). It does not help that faculty, historically, have taken the stance that writing should be taught in the English department and that students should be fully competent communicators by the time they reach upper division disciplinary courses.

In their reflections on early WAC efforts, Young and Fulwiler discussed resistance to WAC/WID efforts on the part of the engineering faculty at Michigan Tech in a few of their pieces (Fulwiler, 1981, 1986; Young, 2003). To help faculty grasp the concept of language as embedded, participants at the workshops were asked to keep a journal and write an essay in stages on the topic of their most memorable writing experience. They wrote freely, revised on the basis of feedback they received from peers, edited, and polished. These pieces were then distributed to the other workshop participants. Faculty who were most responsive to the approach were, not surprisingly, from humanities or social scientific fields. Fewer engineers attended these workshops, and when they did, they tended to be resistant, especially to the de-emphasis on grammar and the lack of quantitative data to support the claims of the participant leaders. Young recounts how the then-titled Michigan Technological University Faculty Senate viewed the program with extreme skepticism even though none of its officers had ever attended a workshop. They went so far as to debate "a resolution [Senate Proposal 6-82] demanding we stop suggesting to students and teachers that there are purposes for writing in which correct spelling, punctuation, and grammar are not essential." The proposal outlined six specific writing abilities the College Entrance Examination Board (which manages the SAT) recommended that all college students needed to perform effectively (MTU University Senate website). Three of the six "abilities" involved mechanical concerns such as sentence structure, grammar, and punctuation. The proposal also included suggested rewrites of the course descriptions for Freshman English I, II, and III, with this "new" focus on mechanics emphasized. (MTU operated on the quarter system at this point and required a full academic year of what we now know as Composition.) While the proposal was defeated, Young remembers one senator describing the WAC effort as "the touchy-feely curriculum," a battle that is still being waged when it comes to general education requirements in the humanities and social sciences.

What makes WAC different from other writing initiatives?

Certainly WAC is not the first initiative to focus attention on writing on college campuses. Russell notes that the shift away from a purely liberal arts education, with its emphasis on rhetoric, to distinct disciplines led to concerns about communication abilities. Harvard was one of the first schools to notice a decline in the writing and speaking ability of its upper division students in the latter half of the 19th century (2002, p.47). Initial attempts to address the issue included written entrance and exit exams, increased instruction in grammar, punctuation, and sentence structure, and other less-than-successful efforts. Writing Across the Curriculum was so different because it pulled the conversation about writing from the confines of the English department and included faculty from all disciplines, recognizing that writing is a rhetorical action and every discipline has its own discourse. For students to be considered successful writers in their disciplines, they needed to understand the conventions of their disciplines. Researchers discovered that, in the process of having students complete reports, memos, journals, etc. within their disciplines, the students learned the course content more effectively and retained that knowledge for longer periods (Bean, 2011, pp. 1-4).

In 2000, ABET, the accreditation board for undergraduate and master degree-level engineering and technology programs in the U.S., began requiring programs to demonstrate that their graduates could communicate effectively as one of eleven student outcomes (Daniels, 2003, p. 140). Since then, disciplinary faculty have worked to incorporate more communication into their courses and, I believe, grown more open to the idea of training their GTAs to provide effective feedback on writing and oral presentations in addition to grading homework problems and exams. However, prejudices remain regarding who is qualified to teach technical writing, especially when perceived language skills of the teacher are factored, as I discuss in the next section.

Resistance to Training ESL GTAs

There is a long-standing 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 belief is that if someone has not mastered the minutia of English mechanics (this supposition about ESL 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 (Flowerdew, 1999)[5]. 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 (Rubin, 1992; Braine, 1999). 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 my research, as opposed to an instrumental approach focused on formats and mechanics (Miller, 1979).

---

[5] Flowerdew studied academics in Hong Kong who were schooled in both English and Cantonese and found that they self-identified the following issues with the English-language writing: less facility of expression, more time needed for writing, difficulty developing effective claims for their research, their composition process influenced by their first language, more difficulty writing qualitative articles versus quantitative pieces, restricted to simplistic style, and difficulty composing introductions and discussion sections.

We must acknowledge, though, that ESL GTAs have different experiences in the classroom than those for whom English is their first language (Lui, 2005). In addition to concerns about juggling coursework, teaching duties, and research, ESL GTAs do struggle with language issues, regardless of their actual ability to write and speak English. ESL GTAs may struggle to establish credibility with their students, especially if they have little or no teaching experience (Liu, p. 157; Maum, 2002, p. 4). Further, Rubin and Kang note that undergraduate students sometimes perceive ESL instructors as being less competent at teaching and less comprehensible speakers based simply on their ethnicity because of reverse linguistic stereotyping (RLS), "in which listeners make assumptions and judgments about speakers based on those speakers' language varieties" (2013). They state that, even in small samples of speech, "listeners naturally attribute social identity to speakers, and then often judge those speakers in accordance with their stereotypes of the speaker's putative social group. As listeners, we make many judgments about speakers depending on how they pronounce words and phrases" (2013). Rubin found that extra training in pronunciation and understanding the expectations of American undergraduate students and classroom norms can help ESL instructors be successful (1992). Although accent is not generally an issue with the ME-EM department GTAs because they all must undergo a language assessment testing their verbal English proficiency before receiving a GTA assignment, it is important to acknowledge the prejudice they might face from students and provide them with the tools and training to overcome such issues.

Research Questions

This research focuses on two research questions. First, using standpoint theory as a starting point to determine GTA needs, what effects do the tools (guidelines and rubrics) and training in formative assessment have on GTA performance, as measured by their own feedback during and after the training as well as feedback from students?

Second, what effects do the tools and training of the GTAs have on the technical writing ability of the undergraduate students once they have completed all three lab courses? Once they reach Senior Capstone Design, do 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?

This study does not critique the lab report as a mode of technical communication; however, during the course of this research I developed some concerns about the lab report format in terms of its pedagogical constraints in teaching concepts such as audience and usability. Thus, in addition to the two research questions detailed above, I also discuss throughout this dissertation the ways in which these concerns informed the development of communication modules for a new curriculum in which the three required lab courses were eventually replaced with four ME Practice courses.

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 (Wirtz, 2014). 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 (Fischer, 2009). Thus, there will be a need for programs that effectively train GTAs in all aspects of classroom instruction and management, helping them develop confidence in their teaching and evaluation abilities, which not only improves their performance but the learning experience of their students as well. WAC programs will find this research particularly helpful if they wish to incorporate GTAs in STEM disciplines into their faculty training programs. This research also reveals an opportunity for interdisciplinary 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 quite thin. The research in question is being 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 scaled to a larger or smaller institution, depending on staff resources and the number of GTAs, and tailored to the specifics needs of any degree program or discipline.

Methodology/Methods

My methodology is rooted in multidisciplinary research (Klein, 1991), drawing on multiple fields of inquiry to explore and assess the outcomes of the training program. My 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 effects (Klein, 1996, pp. 57-61). In addition to the aforementioned field of Writing Across the Curriculum/Writing in the Disciplines, feminist epistemology (standpoint theory), rhetoric (thematic analysis), and writing studies are important in this study.

First, I use standpoint theory as the lens through which to understand the viewpoints of the GTAs and their students (Hartsock, 1983; Harding, 1991). By considering the historical, sociological, and/or cultural location of the basic assumptions of a dominant group and analyzing them from the perspective of the "other," the course of scientific inquiry can change from monologue to dialogue. Hartsock (1983) first advanced the concept of standpoint theory, extending Marxist theory by arguing that women's experiences are vastly different from men's and should be viewed through a narrower lens than as members of the proletariat, invisible in typical Marxist analyses of the time. Standpoint theory removes the "gender-blind" nature of Marx's critique of capitalism by exploring the issues one's sex creates in society, based on one's ability to produce life. Harding extends standpoint theory beyond gender to include all those who are considered "other" in a culture (1991). In my work, the "other" would be the GTAs for whom English is not their first language. Harding advances the concept of "strong objectivity" to counter the "value-free, impartial, dispassionate objectivity that is supposed to guide scientific research and without which, according to conventional thought, one cannot separate justified belief from mere opinion, or real knowledge from mere claims to knowledge" (p. 138). Harding argues that there is a way to conduct research that is less monologue of researcher as observer reporting results to a passive audience and more dialogue between researcher and participant. Strong objectivity maintains the empirical integrity of the research while respecting and engaging those affected by the research, relying on a historical, sociological, or cultural relativism that takes into account a stakeholder's situation and works by questioning the basic assumptions of the dominant group.

I also use 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 (Merriam, 1998; Weiss, 1994; Cresswell, 2003; Boyatzis, 1998). Qualitative research methodology is useful in analyzing texts such as extensive survey responses because it goes beyond a simple counting of types of responses, e.g., "forty people said yes, thirty people said no and five said maybe." 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 (1994, p. 3). I use qualitative methods to capture, via thematic analysis, the perspectives of both undergraduate and graduate students so the undergraduate students have a voice in their learning and the GTAs have an opportunity to speak freely about their concerns as they try to evaluate student writing effectively. Boyatzis (1998) describes thematic analysis as "a process for encoding qualitative information. The encoding requires an explicit 'code.' This may be a list of themes; a complex model with themes, indicators, and qualifications that are causally related; or something in between these two forms" (p. 4).

One benefit of examining student surveys using thematic analysis is that it forces researchers to "go beyond induction" by developing "a theory that is not a simple synthesis of observational statements" (Bendassolli, 2013). While this method does not rule out use of scaling or scoring themes to provide an overall description of results or confirmation of those results (Boyatzis, 1998, p. 160), this process of analysis helps develop a deeper understanding of the data. This means I can justify that what I observe about the data is grounded in objective investigation, i.e. others would likely draw similar conclusions from an examination of the data in question. Given that engineering educators are usually trained to value deductive, empirical research, applying such rigor to qualitative research can make results more acceptable for reviewers in the field (Baillie and Douglas, 2014).

Finally, the GTA training program I developed is rooted in formative assessment theory–that students learn by receiving feedback on their work and then incorporating that feedback to improve performance in the future (Yorke, 2003). However, to determine if the program is actually improving student technical writing I use summative assessment, which Garrison and Ehringhaus (2007) 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." The assessment was conducted by a team of impartial evaluators who completed a training/norming session using the University Student Learning Goal for Written Communication analytic rubric, chosen by the university as a valid and reliable means to assess student writing. The assessors applied the rubric for blind reviews of several technical sections 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 in spring 2015 took all their required lab courses with trained GTAs.

Chapter Outline

This dissertation will be broken down into six chapters as follows:

Chapter One provided an overview of the field of GTA training as it has evolved during the last century and situate my work within the field of WAC) and the related sub-field of Writing in the Disciplines. I explored some unique aspects of training mechanical engineering GTAs in writing, such as language issues described in the ESL literature and perceptions about writing on the part of engineering faculty, graduate students, and undergraduate students (as described in the relevant literature). Further, I discussed how these aspects effect GTAs as they attempt to fulfill a more complex role in the classroom, that of an instructor in technical writing.

Chapter Two includes an overview of the training program including the reasons behind its development and description of its structure. This training program is based on best practices in faculty training developed in WAC over the last four decades; a discussion of these informs the programs development. It also includes a discussion of formative assessment and the way in which it can help students learn to write as engineers. Finally, it incorporates a discussion of rubrics, an integral piece of the training program, exploring the pros and cons of using such tools for evaluation and teaching.

Using standpoint theory as the lens, Chapter Three focuses on the feedback from the GTAs in the form of written responses to questions and in-person interviews before the training program was developed, during the training, and in the semesters following the training. The GTAs' feedback provides a valuable means for understanding their unique perspectives as novice instructors balancing the demands of their own coursework and research with the needs of their students. The feedback also provides insight into what works and what could be improved in the training and what can be realistically achieved in light of time constraints and the rest of the GTAs' academic responsibilities.

Chapter Four includes an in-depth discussion of the results of the student surveys, using thematic analysis to determine prominent themes. It also explores whether student responses were different in MEEM 3220 and MEEM 3000 and how the responses evolved over the six semesters of the survey. Like the GTA feedback, the students' responses provide insight into their views of the role of writing in engineering and on those assigned to teach them such skills. A preliminary exploration of one course survey revealed an appreciation for the department's efforts to improve writing instruction via the labs coupled with some trepidation about their GTA's abilities to evaluate their work effectively.

Chapter Five discusses the results of the summative writing assessment and consider their value in assessing the program. This assessment, using the University Learning Goal for Written Communication, is the best tool we currently possess to compare the writing abilities of students who took classes not taught by trained GTAs and those who did. This chapter also explores some of the implications of using a quantitative tool like summative assessment and consider its value in conjunction with the qualitative methods also used.

Lauer and Asher (1988) note that the final act of an empirical study like this assessment is to interpret and reflect (p. 6). Thus, Chapter Six connects all of three pieces (GTA feedback, student responses, and summative assessment) of the project together and draw some conclusions about what I observed in the data. Based on the results, I explore opportunities for further research and make recommendations for program improvements that could be applied at other STEM-focused, research-oriented universities and WAC programs.

Chapter 2: Program Foundation and Structure

This chapter provides an overview of the GTA training program including the reasons behind its development, a description of its structure and the theory grounding that structure, and the way the program has evolved based on feedback from students, GTAs, and faculty. This overview includes a detailed discussion of best practices in faculty training developed in WAC over the last four decades. It also incorporates a discussion of formative assessment and the ways in which it can help students learn to write as engineers, as well as a discussion of rubrics, an integral piece of the training program, exploring the pros and cons of using such tools for evaluation and teaching.

Identifying a Need

In the essay "Modern Science, Metaphysics, and Mathematics," Heidegger turns to the ancient Greeks to discuss the way Being reveals itself and critiques the way mathematics has been used in modern life to project meaning onto things instead of letting things speak for themselves. Mathematics is used as a tool in a positivist sense in science to quantify evidence so that truth is reduced to binaries of correct or incorrect. When viewed in this light, it is easy to understand why positivists also view language as a tool to project meaning, thus the strict adherence to rules of mechanical correctness. In "On the Way to Language," Heidegger then contrasts the notion of language as an instrument, a tool to be used to accomplish a task, with language as a dwelling of Being, a medium by which Being reveals itself to us. It is, however, the former, the instrumentalist approach, that takes precedence in the sciences, as noted by Heidegger, Merleau-Ponty, and Gadamer. Husserl, while not addressing language in particular in the "Vienna Lecture," decries the positivist turn of Enlightenment thinking, with its laser-like focus on method over pure reason and calls for self-reflection in the disciplines. Such self-reflection did occur in the Department of Mechanical Engineering-Engineering Mechanics, due to the grassroots efforts of myself and a small number of faculty interested in taking the initiative to improving student technical writing. In 2008, this department decided it needed to act on its own to put more emphasis on writing in its senior design courses in an effort to improve what some faculty advisors saw as "atrocious" and "sloppy" writing practices in students graduating with BSME degrees. WAC/WID principles have slowly made their way into the ME-EM curriculum with some measure of success in building the confidence of at least a few faculty members in writing-to-learn concepts. One considerable difference, however, is that it is an initiative that arose from within the department itself and that has been only tangentially related to the Department of Humanities, home to the composition and technical communication courses and one-time home to the university's now-defunct WAC program.

Michigan Tech's ME-EM undergraduate major is one of the largest in the United States, with nearly 1,400[6] students, so class size is always an issue with any pedagogical initiative. Its Senior Design Committee, composed of four faculty and three staff members, decided to make writing instruction a priority despite the large class size (about 100 for the fall cohort and about 45-50 in the spring cohort). The first step was to make writing fifty percent of each team's grade, forcing the students to "take writing seriously," since these students tend to be highly grade-conscious, likely a consequence

---

[6] Fall 2015 enrollment was 1,385 (http://www.admin.mtu.edu/em/services/erlstat/index.php?qtr=fall2015&report=a&map=false&submit=1)

of high GPA requirements by potential employers[7]. Next, a staff member with extensive writing experience was assigned to coach and mentor the teams as they worked through the five reports they prepared over the course of two semesters. This effort involved writing conferences and in-class lectures as well as the eventual development of detailed templates to help teach the teams the rhetorical conventions of engineering design. But this was just beginning.

Those who are experts in teaching writing know that, just as engineering students do not learn all of the math they will ever need in just one course, students need more than a single composition course to learn to effectively express their ideas and that good grammar, punctuation, and spelling are not sufficient for good writing. As David Russell states, what faculty consider poor writing is often the work of a student struggling to develop skills in that particular rhetorical community. That student is attempting to learn and use the terminology and persuasive modes correctly, with little or no formal rhetorical instruction from the faculty (2002, p. 17). This issue of rhetorical expertise, while not explicitly discussed by the Senior Design Committee members, was nonetheless their main concern. While they complained about poor grammar, punctuation, and sentence structure, they were most concerned that too many students graduating with a BSME did not "write like engineers" as Dorothy Winsor describes in her study of the rhetorical practices of engineers in her book *Writing Like an Engineer* (1996, p. 11).

---

[7] Many large employers require a minimum GPA of 3.0 on a 4.0 scale for consideration for internships, co-operative employment experiences, and full-time positions, and some have even higher requirements.

Within a year of beginning its writing program in Senior Capstone Design, the committee agreed that more emphasis on communication was needed earlier in the curriculum so I began recruiting receptive faculty to integrate more writing into their courses. Additionally, a third-year design course was added in 2009 with a heavy emphasis on written and oral communication via rhetorical approach as opposed to a focus on mechanical correctness. Since then, feedback from the department's external advisory board and faculty who teach senior technical electives has been overwhelmingly positive, with two such faculty saying the clarity of their students' writing has improved "tremendously." Still, I believed that the department had the resources to further improve not only student writing, but also more effectively engage our GTAs.

Up until fall 2014, when a new curriculum was implemented, students working towards a bachelor of science degree in mechanical engineering (BSME) 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, were 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 my attention as the department's technical communication advisor. All three courses included technical communication as a learning outcome and as having a moderate or high importance relationship to ABET program outcome “g” (ability to communicate ideas effectively[8]) (see Appendix A for ABET course descriptions). 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 my 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.

Formative Assessment

One method of building communication skills is through formative assessment practices. 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 (Yorke, 2003, pp. 478-479). 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). While formative assessment involves a dialogue with the student, summative assessment is the “final word” on a student’s work and is concerned with evaluating an artefact to determine if a student has met particular course or program

[8] As of publication of this dissertation, ABET is reviewing its criteria and has proposed simplification and rewording of the program learning objectives for academic year 2016-17. See the proposed changes here: https://huskycast.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=338a5393-a4ee-4853-98e8-8e7ed7153bfc.

goals (Yorke, p. 479). Accreditation boards such as ABET are focused on the latter and establish sets of requirements (ABET's ubiquitous a-k student outcomes). Assessments can be both formative and summative, such as exams in which the student can learn from feedback and a grade is recorded that purportedly reflects the level of knowledge demonstrated by the student.

While students are naturally weary of assessment, they like to have their work validated so they seek assessment that indicates if they are learning what they need to succeed in future applications. In general, White (2007) argues that students want assessment that does the following (p. 22):

- Stresses the social and situational context of the writer.
- Is designed to provide immediate feedback to the student.
- Breaks down the complexity of writing into focused units that can be learned in sequence and mastered by study.
- Produces data principally for the use of learners and teachers (rather than bureaucrats, as in the case of standardized tests).
- Focuses on critical thinking and that places surface features of dialect and usage in a large social context.

Yorke also argues that research shows students respond positively to formative assessment, i.e. they appreciate and expect feedback. Whether they actually learn from that feedback depends its timing (do they receive it in time to reflect on it and apply it) and its relevance (does the student see the value of reflecting upon and incorporating it into future work or does she just look at the grade and move on). We must also consider what is fair and effective in assessing the writing of ESL students, of which the ME-EM has a small number at the undergraduate level. Assessment of communication skills of ESL students continues to vex faculty charged with such assessment because of lack of skill on the part of the assessors and cultural disconnection on the part of those being assessed (Matsuda and Silva, 2006).

Hamps-Lyons echoes this sentiment when discussing assessment of immigrant students, stating that, "most composition teachers have no training teaching second-language writing; most of them learn to be sensitive to their second-language writers through trial and errors, which is not the best way when the errors are mistakes made in individual students' lives (p. 227)." While faculty have been shown to be less critical of ESL writing than the writing of domestic students, such laxity can lead to miscommunication between the student and reader. A variation of this issue is a common occurrence in ME-EM lab classes with ESL graduate teaching assistants who do not feel comfortable with their own English skills and, therefore, do not spend time providing effective feedback on lab reports, the first technical writing experience for ME-EM students. This lack of attention catches up with all the students, but especially ESL students, once they reach Senior Design and are finally held accountable for poor writing according to standard American English. After all, if one's incorrect work is never corrected, how does one learn that it is incorrect in the first place?

However, it takes time to provide effective feedback, which is a major reason disciplinary faculty often shun written assignments–the time commitment (Halasz and Brincker, 2006). This time commitment conflicts with four pressures Yorke says are threatening the use of formative assessment in higher education (p. 483):

1) An increasing concern with attainment standards, leading to great emphasis on the (summative) assessment of outcomes.
2) Increasing student/faculty ratios, leading to a decrease in the attention given to individual students.
3) Curricular structures changing in the direction of greater unitization resulting in more frequent assessments of outcomes and less opportunity for formative feedback.
4) The demands placed on academic staff in addition to teaching, which include the need to be seen as "research active," the generation of funding, public services, and intra-institutional administration.

While the ME-EM department faced each of these challenges, the chair and many faculty felt the effort put forth to better train the GTAs in assessing writing would be worthwhile. How best to structure, conduct, and assess that training became the focus of my work, using Writing Across the Curriculum (WAC) and Writing in the Disciplines (WID) theory as a framework. The next subsection summarizes this framework at it applies to faculty training.

Theory in Action–Adapting WAC Training and Tools

While staff and faculty instructors oversee lectures in these lab courses, graduate teaching assistants (GTA) from within the department, most 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. Rather than impose more rigorous standards for evaluation on the GTAs, without also providing additional support, I wanted to understand the factors preventing them from providing effective feedback. By starting from the GTAs' standpoint, we were more likely to develop a training program that could possibly improve their confidence level in evaluating student writing.

However, when first approached with the idea of providing in-house training for the lab GTAs, a few faculty were resistant. They were concerned it would be a waste of time because they believed the international SGTAs could not be trained to teach or evaluate technical writing (despite the fact that one of their primary duties was to grade the lab reports!). This resistance to the idea of training non-native English-speaking (NNES) GTAs is rooted in the outdated belief that good writing can be reduced to proper grammar, punctuation, and style (McRorie, 1985; Parker, 1979). 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. When confronted with the reality of limited resources to teach technical writing outside of the lab courses, opinion gradually shifted towards supporting the concept of training the GTAs in a rhetorical approach to technical writing instruction and formative assessment practices. Such an approach would focus on content and the relationship between the writer and the audience as opposed to an instrumental approach focused on formats and mechanics (Miller, 1979), which was originally advocated for by faculty involved with Writing Across the Curriculum movement on the Michigan Tech campus in the 1970s.

The phrase Writing Across the Curriculum generally denotes formal, campus-wide programming to improve student writing. According to the WAC Clearinghouse, situated at Colorado State University, WAC programs tend to encompass five basic principles (http://wac.colostate.edu/intro/pop3a.cfm, accessed September 1, 2015):

- writing is the responsibility of the entire academic community
- writing must be integrated across departmental boundaries
- writing instruction must be continuous during all four years of undergraduate education
- writing promotes learning
- only by practicing the conventions of an academic discipline will students begin to communicate effectively within that discipline.

Why WAC/WID Works: Living the Language

One aspect of WAC, writing to learn, uses writing as a means of encouraging critical thinking and deep learning (McLeod, 2012, p. 55). The argument is that the process of organizing one's thoughts on the page forces one to engage with the course material at a deeper level, considering not only what was heard in lecture or read in a book, but also what has been observed in one's own experience. In an engineering course such as Mechanics of Materials, for example, a student will likely have witnessed a wooden 2" by 4" board crack and splinter under excessive force applied directly to the center of it, but that student does not yet have the language to express the phenomenon until she learns about bending stress. Heidegger would describe this example as *mathemata*, "things, insofar as we take cognizance of them as what we already know them to be in advance" ("Modern Science", p. 275), which he saw as genuine learning and the product of teaching as giving. Another way to look at this phenomenon is to move the professor from the "sage on the stage" to "the guide on the side," allowing the learner to apply the language to the experience and thus "become" an engineer by living the language of the engineer.

Consider here Merleau-Ponty's concept of motor intentionality and its relationship to language. He argues that "motor memory," which enables us to perform tasks, is possible only because the body first perceives that it is about to do something it has done before (p. 140). Via their core engineering coursework (statics, dynamics, heat transfer, etc.), laboratories, and design project classes, students develop motor skills to operate equipment to conduct tests, use software to analyze a design (through a series of keyboard entries, mouse clicks, or screen taps), and use pen and paper or calculator to solve equations. In this sense, learning is embodied, and skills, once embedded, are demonstrated through motor intentionality. During this process, students are also learning the vocabulary to describe the phenomena they are studying. Writing allows them to reflect on what they have learned and apply that vocabulary to a written record of their experience because simply reflecting on what one has heard or read is not enough to fully engage with the material. Merleau-Ponty notes, "Reflection even on a doctrine will be complete only if it succeeds in linking up with the doctrine's history and the extraneous explanations of it, and inputting back the causes and meaning of the doctrine in an existential structure" (p. xix). Here we see the connection with WAC's emphasis on deep learning, that by reflecting on a topic, organizing one's thoughts, and composing a piece of writing, the student experiences "the doctrine" in a much more holistic manner. Later, Merleau-Ponty argues that, "A thought limited to existing for itself, independently of the constraints of speech and communication, would no sooner appear than it would sink into the unconscious, which means that it would not exist even for itself" (p. 177). There can be little doubt that the act of writing one's thoughts makes them more embedded and likely to be remembered. Think of a trip to the grocery store. Few of us are able to recall each item needed without the aid of a written list. But WAC is about more than remembering what one learns in an engineering class. It is about being able to use that knowledge, and language can be a medium for putting that disciplinary knowledge to use.

In *Truth and Method*, Hans-Georg Gadamer states, "For you understand a language by living in it" (p. 386). This is true whether the language is English or that of a particular discipline, with its own unique jargon. While Merleau-Ponty believes that language cannot be separated from the world, as though one could pick it up like a tool, used to achieve a purpose, and then put away; Gadamer see language as a medium. He states the issue as a "hermeneutical problem [that] concerns not the correct mastery of language but coming to a proper understanding about the subject matter, which takes place in the medium of language" (p. 387). This statement captures the essence of one of the primary reasons for incorporating writing instruction into disciplinary courses–to deepen content knowledge and encourage critical thinking about the subject in question. In my work with graduate students for whom English is a second language, I routinely see a concrete example of this phenomenon. When they come to me for help with editing the mechanics of their theses, dissertations, or conference/journal articles, I invariably notice that the most problematic sections in terms of both content development and mechanics involve explaining their research in non-technical terms to establish the context of their work. However, once they begin describing the scientific and mathematical details of their research, their use of English is much more fluent, especially considering there fewer ways to express concrete scientific principles, e.g. diesel particulate matter, than broader concepts such as vehicle emissions. The language of math and science is where they have been immersed for several years, after all, so the "technical" English has become almost native to them. However, when they converse with their friends about more mundane, everyday happenings, they are more likely to speak in their native tongue. This is why when they try to put their research into the "plain" English common in introductory sections and chapters, they struggle. These students also tend to find it much easier to write than to speak in English because they have time to translate, if necessary, and organize their thoughts. This process of translating thought into text involves deep thinking over time as nebulous ideas take shape on the page. In his discussion of writing, Gadamer says about this process, "A text is not to be understood as an expression of life but with respect to what it says. Writing is the abstract ideality of language. Hence the meaning of something written is fundamentally identifiable and repeatable" (p. 394). He further argues that writing comes to the aid of thought, which is a key component of the concept of writing to learn. In fact, one of the most popular current books on WAC pedagogy, John Bean's *Engaging Ideas*, shows faculty in any discipline ways to use writing to encourage critical thinking and deep learning. Such ideas go back nearly five decades, though, to when WAC first came to U.S. college campuses (Russell, 2002) and then to Michigan Tech in the 1970s, 1980s, and early 1990s. The MTU WAC history is well-documented (Fulwiler, 1981, Young & Fulwiler, 1986; Fulwiler & Young, 1990; Young, 2012) and this research builds on that history.

Michigan Tech's WAC program ended in the early 1990s and there was no writing requirement beyond first-year composition until 2014 when new general education requirements went into effect, stipulating that degree programs designate at least one required disciplinary course as writing intensive. Additionally, the BSME program stopped requiring its students to take a course in technical communication when the university switched from quarters to semesters, restricting program flexibility and requiring a shift in curricular priorities to maintain a 128-credit program, the standard across the nation. Thus, until I began developing a technical communication program within the department in 2008, BSME students received little instruction in even basic technical communication principles until they reached Senior Capstone Design. Even then, instruction was limited to concerns about formatting, and grading involved little feedback and no revision. Based on this history, I turned to Writing in the Disciplines (WID) as a model for the ME-EM department.

WID is related to WAC, however, although a key part of any WAC program, it does not require a formal WAC program structure. Thus WID is not so much a program as a pedagogical tool that incorporates assignments "designed to introduce or give students practice with the language conventions of a discipline as well as with specific formats typical of a given discipline. For example, the engineering lab report includes much different information in a quite different format from the annual business report." (http://wac.colostate.edu/intro/pop2e.cfm, accessed September 1, 2015). Because one of the goals of the BSME program is to develop strong disciplinary communication skills, it makes sense to develop training in WID pedagogical methods for faculty and GTAs within the discipline.

Most faculty within the ME-EM Department have been receptive to the WID approach and committed to the concept that incorporating writing into disciplinary courses is effective at improving retention of course material, not just improving communication ability. It is generally accepted that the act of writing to learn works as a means of encouraging critical thinking and deep learning. To learn from the experience of writing, though, students need more than a grade or copyediting; they need feedback that is instructive (Gottschalk and Hjortshoj, 2004, p. 51). As long as faculty have assistance from trained staff and/or GTAs to evaluate writing and provide feedback, they are amenable to incorporating more writing into their courses or simply emphasizing the importance of the writing that is already a part of the course. For GTAs to respond effectively to student writing, however, they did benefit from training in WAC theory and methodology.

Toby Fulwiler, one of the pioneers of WAC faculty development workshops on U.S. college campuses, wanted to "encourage colleagues in other disciplines to pay more attention to student writing" (Fulwiler, 1981, p.55). The workshops were overnight, off-campus retreats that included discussions of writing expectations, sharing ideas for assignments and assessment practices, and activities to get faculty thinking about their approach to writing and the knowledge they could share with their students about writing in their discipline. While logistics precluded using the retreat format, the training I developed incorporated similar methods. In the first few sessions, I facilitated discussions about how the GTAs felt about writing and what they valued in a piece of writing. There was also some discussion about the role of writing instruction in a mechanical engineering program. They practiced evaluating student writing and receive feedback on their efforts, techniques proven to help evaluators conceptualize best practices in responding to a piece of writing (Young & Fulwiler, 1986).

However, to determine the best approach to training and address the unique challenges of GTAs, it was important to understand the perspective of those most affected–the GTAs themselves. I wanted to build a partnership with them and banish the notion that they were tools to be used by the department to accomplish a seemingly unpleasant task, which faculty either did not want to do or did not have time to do well. In talking with the GTAs, I learned that many of them felt powerless to provide effective instructional feedback because they lacked confidence in their skills as graders and they usually received little to no input from the faculty in charge of the course. Because the GTAs are relatively inexperienced at writing in their discipline, part of the training focuses on the use of rubrics to aid in evaluation and understanding the purpose of lab reports, which many of the GTAs from India and China never encountered as undergraduates because their programs were theory-based as opposed to hands-on practice.

White advocates the use of well-designed scoring guides, also referred to as rubrics, to improve assignment clarity and aid in grading (2007, p. 75). Andrade (2001) argues that rubrics have several features that support student learning (and, conversely, help GTAs new to evaluating writing perform more effectively):

- they are written in a language that students understand;
- they define and describe quality work;
- they refer to common weaknesses in student work and indicate how such weaknesses can be avoided; and
- they can be used by students to assess their works-in-progress and thereby guide revision and improvement

She notes that most rubrics include a detailed list of criteria for the assignment and performance descriptions for each criterion. In the case of the lab reports, the rubric included each section of the report and descriptions of what constituted an "excellent" section, "good," and so on. Not everyone agrees with value of rubrics in evaluating writing, in part, because they may constrain the writer and the evaluator, possibly stifling the creative act of composition (Wilson, 2006; Broad, 2003). However, the rubrics and lab report guidelines worked in helping GTAs be more consistent and develop confidence in evaluating content in the lab reports.

Before moving on to a discussion of program structure, I will explore the lab report genre in more detail to provide a clear portrait of its limitations as a teaching and learning method in technical communication.

Critiquing the Lab Report Genre

The lab report is a genre specific to the empirical sciences, a means of communicating knowledge gained during a lab experiment, an ubiquitous feature of science and engineering programs. Carter states that "the lab experience is a way of doing that is directed toward a way of knowing. It is primarily in writing the lab report, however, that doing becomes knowing" (2007, p. 388). Perhaps because of its ubiquity, the lab report genre has not been critiqued as to its true value in modern engineering education with its relatively recent turn toward more emphasis on critical thinking and design, though. Berkenkotter and Huckin argue that "genres are inherently dynamic rhetorical structures that can be manipulated according to the conditions of use, and that genre knowledge is therefore best conceptualized as a form of situated cognition embedded in disciplinary activity" (1995/2004, p. 285). However, just how "dynamic" is the traditional lab report that has been used in engineering and science curricula for decades? Looking at just one aspect, usability, which Gould and Lewis define as easy to use, easy to learn, and useful or relevant (1985), it begs the question of whether lab reports are the most effective way to learn to communicate as engineers and to think critically about the information presented as part of the lesson demonstrated by a particular experiment. The fact that we were able to develop a set of guidelines applicable to all three labs demonstrates the formulaic nature of the reports. The reports mirror the structure of a scientific journal article, with an abstract and introduction, followed by background, objectives, results, analysis, and conclusion sections. Unless a student plans to attend graduate school in engineering, the document format has limited relevance outside the classroom since industry test reports are expected to be much less verbose and are usually completed using a template provided by the company.

As we will see in Chapter Four, this rigid format and its lack of relevance did not go unnoticed by some students who expressed concerns that there was too much emphasis on formatting and not enough on concepts demonstrated in the lab work.

Petraglia refers to such assignments as pseudotransactional writing, which is "solely intended to meet teacher expectations rather than engage in a transference of information for the purposes of informing the uninformed or demonstrating mastery over content" (1995, p. 21). Recognizing this limitation, I strongly encouraged students to participate in internships and cooperative education opportunities to obtain a broader and deeper understanding of communication principles through practice in a "real world" environment, which has been shown to be an effective method of learning (Spinuzzi, 1996/2004; Anson and Forsberg, 1990). Also, when the department crafted a new curriculum, lab reports were exchanged for a wider variety of assignments in the practice course that replaced the labs. At the time of inception of the GTA training program, however, it was easier to focus attention on improving evaluation and instruction of the existing assignment than overhaul the structure of the courses.

Program Structure

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 (Michael Meyer) 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 students' failure rate by a significant amount thanks to a GTA handbook, common rubric, and grade norming sessions, all of which helped the GTAs teach the material more effectively.

Once the ME-EM department committed to providing its own training, I established a team to help develop sub-goals, a set of lab report guidelines and rubrics to aid evaluation, and appropriate content for each session. The team included two lead course GTAs, Timothy Jenkins and John Armstead (who have since earned their PhDs and left the university), and six faculty (five lab instructors and one course coordinator). The three sub-goals included: 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 engaged in spirited discussions about 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. This information was then 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
- the GTAs 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, and
- ways to provide the most effective feedback in the least amount of time

I designated a "lead" GTA at the start of each academic year. This GTA was chosen based on years of experience as a lab GTA, student/faculty evaluations of past performance, and leadership potential. The lead GTA attended all of the training session and was a resource/mentor for the rest of the lab GTAs. To facilitate discussion of what it meant to provide effective feedback on student writing, I used Beth Hedengren's book *A TA's Guide to Teaching Writing in All Disciplines* (2004) as the main text. The GTAs were also asked to review the set of guidelines and rubrics (discussed in depth later) so they could use them to show rather than tell students the paths to writing more effective prose in a disciplinary context. 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 mechanical issues; rather they were 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 if they were numerous. We then practiced using the guidelines and rubrics to provide feedback on a sample lab report and we discussed their feedback as a group, highlighting wording that is particularly effective in guiding the student towards improved clarity.

Session 1

The first session was held during Week 0, the week before fall or spring semesters began, when GTAs were expected to report to campus for graduate orientation and/or course preparation. The objective of this session was to provide some background on WAC/WID and possibly allay some of their fears about evaluating student writing. I began this first session with introductions, asking each GTA to tell the group their name, status in the program (M.S. or PhD), the course to which they were assigned, and their impressions of their own experience with learning to write in engineering. These introductions, especially in a group of at least five, helped the new GTAs get a sense of the commonalities between them and begin to see themselves are part of a community of novice instructors (Berliner, 1988, p. 40).

Next, we discussed two questions: 1) what is it we really want the GTAs to accomplish as they evaluate student lab reports? and 2) how could they communicate the task requirements to their students? As noted earlier, writing teachers know that becoming a more effective writer requires feedback that encourages critical thinking about one's own work. Students need to understand their subject matter, the purpose of the document, and their audience's needs. Thus, in the first two sessions, I, along with any faculty who chose to attend, discussed the purpose of the labs and ways to ensure that students understood the purpose as opposed to simply following a series of steps to complete the lab procedure. We also discussed the particular placement of each lab course within the curriculum so the GTAs could see how the courses connected with each other and the department's goals regarding technical communication competency for students graduating with BSME degrees. I also presented a brief overview of WAC theory, which for most of the graduate students, involved new concepts, having come from undergraduate programs where writing was not emphasized as much and feedback was minimal. The natural tendency of many new teachers evaluating writing is to simply mimic the behavior and methods of their own instructors, which may or may not be effective, depending on the quality of instruction (McLeod, 2012, p. 63). Those GTAs who had to write lab reports as undergraduate students often described receiving the kind of feedback we want to avoid, that focused only on local issues (grammar/punctuation) or reviews of their calculations and findings without any feedback on the content and structure of the writing itself. Thus, one purpose of the training was teach the GTAs an evidenced-based method of responding to student writing.

Also, as part of the introductory portion of the training, I distributed and discussed the purpose of the guidelines and rubrics developed by the team for the courses. While I stressed that these tools were developed by a committee of faculty and two GTAs, drawing on many years of experience, I also emphasized that their feedback, as the main users of these tools, was expected and valued. Then, I distributed a copy of a poorly composed student report (name redacted) for them to practice evaluating using the guidelines and rubric prior to the next session. Finally, we discussed the resources available on campus to help them, including each other (with a brief reminder of FERPA guidelines), the course instructor, that academic year's lead GTA, the university's Center for Teaching and Learning, and the Multiliteracies Center.

Session 2

The goal of the second session, which lasted two hours and was scheduled during the first week of classes, was to further explore the importance of providing effective feedback in improving writing. We spent the first hour discussing the first six chapters in Hedengren's book. While discussing Chapter One–Getting Started, the GTAs responded to a prompt at the end of the chapter asking them to write for five minutes about any fears they might have had about helping students with writing and what experience they thought they had to offer a student in terms of technical writing guidance. We then discussed everyone's responses. At the end of this exercise, I asked the GTAs to think of the qualities of effective technical writing and then listed these on the whiteboard. To meet the increased cognitive and behavioral demands of complex tasks such as evaluating student writing, Stajkovic and Luthans note that trainees may not perceive they have the skills and abilities to perform the tasks despite their experience and knowledge (1998). Showing the GTAs what they already knew helped build their confidence. I drew upon standpoint theory[9] to provide such support in that I asked the GTAs to put themselves in the shoes of their students and think about what they wish their instructors had done when grading their own papers. Such reflection helped the GTAs avoid the pitfall of falling back on what their own instructors had done that was not helpful in improving their writing and incorporate into their practice techniques that had worked well.

Other topics of discussion included the concept of writing to learn, the formal writing process (prewriting, drafting, revising, and editing), and the process most often used by their students (drafting and submission). At this point, I emphasized that they were to focus on global issues in the students' work, not local issues such as mechanics,

[9] Standpoint theory, introduced in Chapter One and discussed further in Chapter Three, is a concept first put forth by Hartsock (1983), who asks researchers to consider the perspectives of non-dominant groups affected as opposed to the typical white, heterosexual male viewpoint. By doing so, a more accurate portrait emerges.

which further allayed their fears about responding to student writing. As we will see in Chapter Five, such an emphasis proved effective at improving many aspects of student writing, including control of syntax and mechanics.

The second hour was devoted to the practice lab report evaluation exercise. This exercise evolved over the course of the training, as I learned what worked best for the GTAs. The idea behind giving them practice early on was for them to demonstrate their current method of providing feedback (likely learned from their own experience as students) and receive some guidance for improvement. During the discussion, we referenced a model report with feedback from John Armstead, a member of the original development team, while going through each section of the report and comparing each GTA's responses. Through this exercise, the GTAs were also able to raise questions about the guidelines and rubric and hear how their colleagues interpreted these tools. In some semesters, faculty from the lab courses would attend this particular session and provide input as well, which the GTAs found more valuable than simply hearing from their peers. It was the success of these faculty-attended sessions that led me to require grade-norming sessions be held during at least one prep meeting for each lab course early in the semester, a practice that continues in the new curriculum.

Session 3

The final two-hour session, typically held during the second or third week of classes, provided an opportunity to "check in" with the new GTAs since they would have experienced at least one lab session and likely evaluated the related lab reports. We then discussed chapters 8 through 11 in Hedengren's book, focusing on writing conferences, conducting in-class workshops, commenting on student work, and defining fair and consistent evaluation. The lead GTA, faculty in attendance, and I would often provide tips for evaluating reports quickly while still providing feedback that would help students improve future submissions. Examples of tips we shared included:

- Tell the student what is good about the report;
- Guide the student toward strengthening weak sections by phrasing comments in a way that makes the student think about the assignment more critically, which results in better reports in the future, therefore making evaluation easier by the end of the semester, e.g. “Could there be another explanation for these results?” or “Can you provide evidence to support your claim here?”
- Think with a “beginner’s brain” when evaluating, meaning understanding that, while they may have thorough knowledge of the concepts presented in the lab, this may be the first or second time the students have encountered them so they will need more explicit instruction.
- Scan each paper before making comments to see if most of the students are making the same mistake and provide guidance in class rather than mark every single paper.
- Do not feel bad about giving a low grade to a report. Students earn their grades. There should be no “easy A’s” in college.
- Have “grade-norming” sessions periodically with all of the GTAs in the course to ensure everyone is interpreting the guidelines and rubric the same.

Session 4

The goal of this 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. In this session, we discussed chapters 13 through 15 in Hedengren's book, covering plagiarism, professionalism, and time management. We discussed using the "turnitin.com" function on Canvas, which we incorporated into each lab course in fall 2012. We also reviewed the department and university procedure on handling suspected cases of plagiarism, which had long been an issue in the MEEM 3220 Energy Lab[10]. At the request of the course coordinator, I also instituted a lecture (attendance was mandatory) on ethical publication and citation practices at the beginning of the semester in the Energy Lab. The number of plagiarism cases dropped to zero in spring 2015, the last large (120+ students) section of the course, from a high of about a dozen a few semesters earlier.

Finally, the lead GTA was especially helpful in providing insight into time management, recommending that they follow Hedengren's advice to "respond more thoroughly to the first paper the students submit, and be very rigorous on that paper's evaluation" (p. 144). Experience has shown us that this tactic is very effective at getting students' attention and helping them understand what is expected of them for these lab reports.

---

[10] The labs in MEEM 3220 had not been altered for many years, affording students the opportunity to "reuse" reports passed down from prior years. Faculty were aware that plagiarism was a problem, but, other than checking each and every report against past reports (which turnitin.com does via Canvas), there was no realistic way to catch perpetrators.

Session 5

This 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. I wanted 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. This is also perhaps the most difficult step because it requires a team effort from faculty, the experienced GTAs, the new GTAs, and the training coordinator. Each GTA must feel comfortable approaching others for feedback and guidance if s/he is having difficulty with something. Stajkovic and Luthans recommend that managers set clear and objective standards so employees can accurately evaluate their own performance and measure their progress (1998). Further, Bandura states, “Given definite aims and feedback about one’s performance, efficacy beliefs function as influential regulators of motivation and performance attainments” (1997, p. 66). It is difficult to motivate oneself to maintain a high standard of performance if one has no idea if she completed the task correctly.

Lead course GTAs, the mentor GTA, and faculty must be proactive in spotting when a GTA is struggling and provide adequate guidance because the coordinator is not in day-to-day contact with GTAs in training. We learned this lesson when a course head GTA discovered towards the end of one semester that one of the GTAs was behind in grading several weeks of lab reports, meaning the students in his sections had received no feedback or grades in the last half of the semester. This particular GTA had performed quite well in previous semesters, but was in a difficult position because his research advisor needed him to complete a complex project at the expense of his GTA assignment.

Conflicts such as these are best resolved by the department's graduate program director and chair, but we have since put in place mechanisms to ensure that GTAs do not fall behind in their grading by having the head course TA or the instructor check the Canvas gradebook on a regular basis. Since the ultimate goal of the program is to improve student writing, it does no good to have students receive feedback on their work after the course is complete and they have lost access to their Canvas course files.

In closing this section, I want to stress that these sessions are not so much a series of steps as an iterative process, where the teaching team and the GTAs take the opportunity to continually reflect on what they have learned, how they have applied it in their classes, and how they can improve their teaching in the future. This was especially true for the final two sessions, which helped bring together everything they learned in the readings and discussion in the first three sessions as they practiced the craft of evaluation. The graph in Figure 2 illustrates this iterative flow. While the training has evolved, this iterative process has remained.

Evolution of Training: Adapting to the needs of the program and GTAs

Since its inception, this training program evolved in its mode of delivery and the content based on feedback from the GTAs, students, and departmental needs. The most significant change is in the mode of delivery. Beginning in the spring 2015 semester, the training program was converted to a self-paced online course of five modules available on Canvas, the university's learning management system, to be completed by the end of week five of the semester. The two main reasons for this switch were difficulty in scheduling convenient times to meet as a group and a desire to incorporate content related to encouraging an inclusive classroom environment and additional assignments. With the

Figure 2 Iterative process of GTA training sessions

elimination of in-person meetings, though, I now meet with each course teaching team on a rolling basis, i.e. ME Practice 1 and 2 in week two, ME Practice 3 and 4 in week three, and then back the following week as needed. These meetings give me the chance to hear from the GTAs in the context of their course, answer any questions they have about evaluation, and provide guidance on areas of concern. The effectiveness of this switch in delivery mode, content, and type of in-person meetings is outside the scope of this study, but could be the subject of future research.

Developing Similar Training Programs Elsewhere

As noted earlier, Michigan Tech has not had an active WAC program for more than twenty years; however, such a training program could work 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, Michigan Tech'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 (see footnote 1 in Chapter One) might find this training useful).

As the example of the ME-EM 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.

Chapter Three: The GTA Perspective

This chapter focuses on the GTA standpoint and the ways in which the graduate students contributed to improving the training program and revising the undergraduate curriculum. I first discuss the theoretical framework for valuing the GTA perspective. I then explore some of the feedback gathered from the GTAs via in-person interviews, round-table discussions, and written responses. Finally, I discuss how this feedback affected the program and curriculum.

Making the GTAs Partners in Research

Research in Writing Across the Curriculum and its subfield, Writing in the Disciplines, is rooted in the social and historical context of writing instruction and the rhetorical context of the written word in a particular discipline (Russell, 1992). It is also concerned with the student perspective, though, so the three methods[11] I used to collect and analyze data address issues of objectivity and inclusiveness by exploring multiple positions. A key factor in the development and evolution of this program is the input from the GTAs themselves regarding the content of the training so that it addresses their needs as well as the students they serve. This perspective was ascertained through a combination of written responses to questions posted via email or Canvas, individual interviews with the GTAs, and group meetings. The meetings took place in a round-table setting with faculty and arose from a need for collaboration between departmental faculty and the GTAs as well as to empower the GTAs to clearly express their needs. In reviewing the notes from their responses, I looked for common themes, but gave every

[11] The three methods used are interviews/written feedback from the GTAs, undergraduate student surveys, and summative assessment of Senior Design final reports.

response equal weight. Like the undergraduate student surveys to be discussed in Chapter Four, the use of written and oral responses from the GTAs to develop and evaluate the training program builds on aspects of social and historical construction (Berger and Luckmann, 1967), because both groups of students have been socialized to function within a particular education system. These responses also include empowerment and collaborative knowledge claims, because both groups are provided a "voice" in how and what they are taught or trained (Bandura, 1977, 1986, 1997, & 1999; Hartsock, 1983; Weiler, 1988). Before discussing the feedback from the GTAs in this chapter, I situate my work within the field of qualitative research.

Evolution of Qualitative Research in Writing Studies

Research methodology in the social and human sciences has evolved in the last five decades, with the most change occurring in the last two to three decades as views on ontology and epistemology have expanded to be more inclusive and to more effectively address the needs of diverse populations. Early social research relied almost solely on quantitative research methodology, which uses the scientific method of close observation and measurement of a so-called objective reality. In this methodology, the researcher starts with a theory, gathers data to confirm or refute the theory, and then revises the theory as needed and conducts additional tests to confirm or refute the new theory (Cresswell, 2003, p. 7). Quantitative methodology is rooted in positivism, an epistemological approach focused on what is knowable as an absolute truth, what can be represented statistically, and what can be replicated and applied universally (Steinmetz, 2005, p. 32-33). It relies on a closed system, which means there is no room for anomalies, conjecture, or variance based on uncontrollable factors, e.g. human unpredictability. With dramatic social, political, and military unrest throughout the twentieth century, positivism lost some of its following, as many human science researchers sought methods of inquiry that were more inclusive and could address how race, class, and gender affected results. By the 1990s, qualitative research, with its emphasis on strategies like ethnography, grounded theory, case studies, and narrative research, had gained wide recognition as a valid means of studying human issues. In that period, though, another means of conducting research emerged, one that combined aspects of quantitative and qualitative research methodology in what is called mixed methods research (Cresswell, 2003). To understand the reasons behind this evolution in research methodologies, I wanted to understand the philosophical underpinnings of these different approaches so that I could best situate my research, which is interdisciplinary, encompassing broad fields such as rhetoric, writing theory, and engineering education. However, before determining which methodology to use, Cresswell suggests considering three questions:

- What knowledge claims are being made by the researcher (including a theoretical perspective)? Knowledge claims are the assumptions a researcher works from in terms of how they will discover information and what information they will discover during their inquiry.
- What strategies of inquiry will inform the procedures? This is the more applied aspect of developing a research plan and includes an ever-expanding array of strategies such as experiments for quantitative research, ethnographies and case students for qualitative research, and sequential, concurrent, or transformative strategies for mixed methods research.

- What methods of data collection and analysis will be used? Cresswell notes it is helpful to consider many possibilities for data collection in any research project to arrive at the most effective methods for developing the most complete picture of the situation in question (p. 17).

Using these questions as a guide, I will now explore where my work best fits and why particular epistemologies speak to me more than others.

Knowledge Claims

Although many theorists once divided quantitative and qualitative research into two distinct paradigms–positivist and interpretive respectively (Merriam, 1998)–such a division is no longer seen as valid or necessary. In a review of the literature on mixed methods research, Niglas notes that beginning in the early 1980s, many researchers argued that quantitative and qualitative research methodologies are not mutually exclusive because they are not diametrically opposed practices (Niglas, 2004, pp. 5-6). Instead, they are better represented as a continuum, encompassing researchers with a wide range of philosophical and methodological preferences that go way beyond labels such as "positivist" or "interpretivist." In fact, Cresswell describes four "alternative knowledge claims" on a continuum that places quantitative research at one end and mixed methods research at the opposite end (Table 1). In the quantitative camp, we would expect to find researchers who believe empirical observation and measurement or theory verification (the scientific method) are the most valid means of exploring a problem. Researchers who use qualitative methods only might work from socially constructed knowledge claims or advocacy/participatory knowledge claims. Finally, those researchers using mixed methods often identify themselves as pragmatists

(Cresswell, 2003, p. 18). I will explore each of these categories in more depth to situate my own work, which shares some features of all four positions, to meet the needs of different constituencies.

Table 1 Alternative Knowledge Claim Positions

Postpositivism Determination Reductionism Empirical observation and measurement Theory verification	**Constructivism** Understanding Multiple participant meanings Social and historical construction Theory generation
Advocacy/Participatory Political Empowerment issue-oriented Collaborative Change-oriented	**Pragmatism** Consequences of actions Problem-Centered Pluralistic Real-world practice oriented

Situating My Work: My research falls into the mixed methods category, using focus group interviews, personal written responses to questions, open-ended surveys, and quantitative writing assessment, and thus incorporates a variety of perspectives that are dependent upon the subject of a particular method and the research question to be addressed. Bryman (2006) discusses nearly two dozen reasons why someone would choose a mixed methods approach; two in particular speak to my needs, completeness and credibility. Bryman defines completeness as "the notion that the researcher can bring together a more comprehensive account of the area of enquiry in which he or she is interested if both quantitative and qualitative research are employed" (p. 106). Credibility "refers to suggestions that employing both approaches enhances the integrity of findings" (p. 106), and is a key factor in getting research in engineering education recognized and published by the American Society for Engineering Education. Engineering education research has long relied on quantitative approaches, with a strong emphasis on statistical analysis, a remnant of positivism. Steinmetz (2005) notes that “[d]espite repeated attempts by social theorists and research to drive a stake through the heart of the vampire, the disciplines continue to experience a positivistic haunting” (p. 3). However, the field is growing more receptive to qualitative approaches as well as mixed methods research, in part because of the increasingly interdisciplinary nature of education research (Baillie and Douglas, 2014). Validity of such research, though, is still a concern for reviewers, which is one reason I chose to use multiple methods of data collection and assessment in my work (I will address the issue of validity in Chapter Five). Next, working from Cresswell’s knowledge claims model, I will address strategies of inquiry.

Strategies of Inquiry: Standpoint Theory and Strong Objectivity

While writing theorists usually fall into the constructivist, advocacy/participatory, or pragmatist categories, writing assessment is an empirical measurement tool, rooted in the scientific method, with a control group, blind review, and established metrics for measurement. As noted earlier, Cresswell places this type of research on the quantitative end of the research spectrum but differentiates it from the original positivist (Cartesian) approach because today’s quantitative researchers no longer accept the idea that there is one truth to be determined from research. Instead, they see “knowledge as conjectural … [that] evidence established in research is always imperfect and fallible” (p. 7). Writing assessment is discussed in detail in Chapter Five so I will not belabor the issue here other than to say that such an assessment provides a piece of the answer to the research question of whether the lab GTA training program I designed and implemented was effective at improving undergraduate student writing. One of the goals of quantitative research is to analyze data and evidence in a rational and objective way to establish knowledge. However, the question of objectivity is sometimes obscured in quantitative research, which is why including qualitative methods can provide a more comprehensive and inclusive representation.

My strategy of inquiry incorporates standpoint theory and its related concept of strong objectivity[12], which argues that, to be valid, research must take into account the perspective of the research subjects themselves. Researchers should abandon the myth of scientific neutrality and acknowledge their roles as members of certain dominate groups; e.g. highly educated, middle class, often white, and often male. An outgrowth of feminist epistemology, standpoint theory afforded me the opportunity to incorporate the unique perspectives in developing and revising this training program within an existing theoretical tradition – feminist pedagogy. Eschenbach et al. (2005) describe the ways in which feminist values can inform engineering education:

- Social Justice: Each person's dignity is honored, each person's needs are recognized and addressed, and any person's or group's claims to extras are anchored in merits or needs widely agreed upon and open to debate among members.
- Democracy: Each person's voice is heard or at least effectively represented and that no one buy or bully her or his way into other people's lives.
- Individuality: Individuals and expressions of individuality are valued, even while feminists often decry rugged individualism.

[12] I described strong objectivity in more depth in Chapter One.

- Responsibility: Extending responsibility beyond oneself and one's circle of loved ones, especially to those who depend heavily on the rest of us for sustenance and nurturance.
- Inclusionary Thinking: Women (and men) are diverse and no one subset can represent the whole set. Every societal problem needs a wide variety of people working together to find solutions.
- Freedom, Liberation, and Self-actualization: We should aim to enhance women's freedom to choose the circumstances and purposes of their lives, but be disinclined to prescribe anything specific for women. (Eschenbach et al., 2005, F4H-8-9)

These values informed every aspect of my project as I worked to build an inclusive environment where GTAs, faculty, and undergraduate students could interact with respect, regardless of background, moving past stereotypes about ethnicity and language, and the traditional boundaries of academic hierarchies. Harding argues, "[O]ur cultures have agendas and assumptions that we as individuals cannot easily detect" (149). The employment of strong objectivity forces the researcher to uncover the micro and macro tendencies in "the social order," thereby revealing the biases that lead to distorted beliefs as well as empirically viable beliefs. She states, "[w]e can think of strong objectivity as extending the notion of scientific research to include systematic examination of … powerful background beliefs" (149). This "making the strange familiar" should be the starting point for scientific inquiry, engaging in reflexivity to pull back the layers of mystery shrouding some practices that may have stood for centuries based on "bad" beliefs.

In the next section, I present the perspectives of many of the GTAs who participated in the training and discuss the ways in which their input was used to improve the program.

The GTA Standpoint

My 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 provide 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" (Haraway, p. 117). 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 dictated their research schedule 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. I 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 with 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 did not receive a high grade. Because these GTAs are often already self-conscious about their English language skills, they might avoid the issue of grades by assigning no grades lower than a B for lab reports. Dylan[13], the lead GTA for one course in the fall 2014 semester reported that some sections of students will "manipulate" their GTA into believing he or she is grading too harshly by making comparisons with grades they claimed their friends received in past sections..

Based on such feedback, I now discuss power dynamics at several points during the training. I encourage them to take control of their graduate experience in the classroom and in their research by making explicit the importance of their role as authority figures, evaluators, and mentors in their classroom so they can develop as future faculty members, a career sought by more of the foreign GTAs than those native to the United States. Whether simply making these power struggles explicit improves the GTAs' self-efficacy in their roles as future faculty and researchers is not yet known and would make for an interesting study.

How GTAs related to their students

The ways in which the GTAs related to their students in and out of the classroom was, however, often connected to their stress level. GTAs who were most concerned about being overextended between their coursework, research, and teaching duties were also the ones who viewed their GTA role as that of task master, ensuring students completed the labs safely and correctly, rather than a teacher providing guidance. For example, Dylan felt the students were taking advantage of his time by coming to him

[13] All GTA names are pseudonyms, unless otherwise noted.

with “basic questions.” Others, like Anwar, approached the job with a different mindset. As a GTA for the second-year course, he stressed the importance of being available for students who sought help. He wrote in an email after one mid-semester GTA meeting, “Based on the students I have met, they don’t seek help because they don’t want to ‘feel stupid.’ If you tell them to go figure it out themselves, in many cases, you are just reinforcing that feeling. If they can’t ask the GTAs, who will they turn to?” It was after this exchange that I added a discussion of “beginner’s brain” to the training.

One thing Deepesh and other GTAs struggled with was the need to balance thoroughness with expediency. Deepesh said, “Sometimes I would get very concerned about returning the graded assignments as quickly as possible, which affected my grading, but then I realized that it was better if I was more thorough with evaluation even if it mean taking two or three days longer.” (As discussed in Chapter 4, the timely return of graded assignments was also a concern for the undergraduate students.)

Having a rubric went a long way toward 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 “added clarity to grading” for both students 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 (2003) 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 (pp. 78-81). 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 language-wise to defend their decisions in English. They were also concerned about receiving poor evaluations from the students and possibly losing their GTA funding. The department's graduate program director, who assigned GTA positions, made it clear, however, that he had never "fired" a GTA for being a tough grader and, generally, the student survey I developed showed that students were more focused on whether they actually learned something in the class when evaluating a GTA, not whether the person was "an easy grader."

Feedback Regarding the Training Itself

There was some confusion about how this training related to another required course, ED 5100 College Teaching (later titled ED0510), which taught through the Center for Teaching and Learning. All ME-EM department GTAs were required to take the one-credit, seven-week pedagogy course, but they could take it at their convenience, meaning they might have been a GTA for a few semesters before taking the class. That course focused on how to develop a syllabus, design assignments, and interact with students on a professional basis. Some of the GTAs felt the course was not particularly helpful since they did not create syllabi or assignments. If new GTAs signed up for that course their first semester, they needed help in understanding why both training programs were required, as taking both could be time-consuming due to all the reading required. Additionally, those students who had the training in evaluating writing before taking ED

5100/ED 0510 requested that the department's training include instruction in handling conflict and designing lectures.

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 Michigan Tech, Greg felt the students should be required to take a technical communication course, as he had, and that is was not the place of engineering faculty or GTAs to teach writing. This GTA was also a staff member in a different department on campus and had several years of experience working with MEEM 2500 students. His attitude was much more common during WAC's early days on campus (Fulwiler, 1983 Young, 2012). Ironically, all of the lab course coordinators were on board with the idea that engineering students learned the language of engineering in disciplinary courses so it should be the responsibility of engineering faculty to teach them how to communicate as mechanical engineers.

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."

Sources of Frustration

By having the GTAS openly share what was not working for them, we were able to fix problems or at least lessen their impact. For example, the university's online learning management system, Canvas, was a source of frustration for some GTAs and a blessing for others. Canvas provided a convenient way to evaluate student work online through an application called Speedgrader that, once the rubric was programmed into the system, allowed the GTAs to simply click on the appropriate category to assign a grade and then add comments in a separate box. Early adopters of Canvas (the LMS was instituted in fall 2012) for grading tended to be the GTAs with the most experience in the classroom. They saw the program as a timesaver; however, the new GTAs felt they needed much more training to become adept at its use. In response to this concern, I arranged for staff from the Center for Teaching and Learning to provide some additional training in Canvas for a few semesters until the majority of GTAs and faculty felt comfortable using it and could then train newcomers on the key features. The CTL also created a series of tutorials, which the GTAs found most helpful.

One source of frustration for myself and the GTAs was the sizable number of student who did not bother to look at the written feedback. The Senior Design advising team addressed this issue by making the incorporation of feedback a part of the report grade, but this tactic was not an option in the lab courses because of the number of reports due (usually one a week), making it impossible for a GTA to spend time looking at a report twice. Geng was a GTA for two of the three labs during his career and he noted that students would switch who wrote the lab report in the group and that may have been why they ignored comments on a report they did not write or would not have to write again. This lack of attention paid to the feedback led some GTAs to feel the time they spent writing comments was wasted, especially when they saw students making the same mistakes repeatedly. In a subsequent year, the Energy Lab faculty member noted that his GTAs almost never posted comments on lab reports, but did not think the students were concerned because he had received no complaints. The survey from that course that semester revealed that many students would have liked more feedback, though.

Related to inattention to feedback was a problem with students not reading the lab manual[14], guidelines, or rubric before beginning to work a lab experiment. Several GTAs found their students were unprepared to work the lab when they arrived in class so they instituted Canvas quizzes prior to each lab that forced the students to read the manual. In fall 2013, the lab teaching team developed a quiz on the report guidelines and rubrics so we could ensure the students had at least skimmed those documents. Subsequently, GTAs reported their students made fewer formatting errors and mistakes related to not following the report guidelines or particulars of the lab procedure.

Experience, or lack thereof, and the resulting anxiety was another common theme. That anxiety manifested itself in two ways: unfamiliarity with the lab course format and equipment and insecurity about confrontational interactions with students concerning grades. A GTA in his first year of teaching noted that he had had no experience with lab courses as an undergraduate in China, where the engineering curriculum was focused on theory and computation, not application. He took it upon himself to attend lab sections taught by more experienced GTAs to see how they explained the lab requirements to the students and how they taught the students to use the equipment.

[14] Each course had its own lab manual that provided instructions for the labs, including what equipment to use, data to collect, and questions to answer.

Another participant in that first series, Deepesh, was new to both graduate school and teaching and found that modeling how a more experienced evaluator presented feedback was most effective for him. We accomplished this by having norming session with the GTAs and faculty from each course discuss one or two reports. The faculty member would then describe his[15] feedback and his reasoning for assigning a particular score to a section. To help GTAs avoid confrontations about grades, faculty in all three courses encouraged the GTAs to refer students to the faculty if they had any concerns related to their scores. Because the faculty usually had higher expectations than the GTAs, the students rarely argued about a lab report grade more than once a semester.

Faculty also expressed concerns and compliments, especially during the first year of the training. The instructor associated with the second-year course was satisfied with the amount of effort put forth by the GTAs and believed the effect of a good GTA lasted for students long after the course was completed. Conversely this same instructor was concerned that the GTAs were not effective in using the language of engineering with their students. Some GTAs either used engineering terms incorrectly or not at all. This could have been the result of lack of English proficiency or lack of knowledge. We addressed this concern by placing more emphasis on having instructors or senior GTAs train the new GTAs on the equipment and ensure that they understood the engineering theory underpinning the lab.

In fact, the most common concern expressed by the GTAs upon beginning the training was their lack of proficiency with the intricacies of the English language. While this issue was most often expressed by ESL speakers, domestic GTAs occasionally

[15] All the participating faculty were male.

described themselves as less-than-skillful writers. This is one reason I began having the trainees list the qualities of effective technical writing, based on their own experience, so they could see how much they *did* know. Of course, I also continued to emphasize that they were to focus on content, not the mechanics of writing, which aided in building their confidence. I discuss the issue of language proficiency in the next section.

Key Conclusions Regarding the GTA Standpoint

I draw two key conclusions from the GTA's feedback. The first conclusion is that empowering the GTAs to provide input on decisions affecting their jobs led to a stronger sense of commitment to their students, which translated into providing more effective feedback on reports. By having them share their expertise with faculty, other GTAs, and myself, they saw that they could affect change in the tools and training that helped them improve their own teaching and learning experiences and those of their students. As noted in the next section, the GTAs provided valuable insight as the department began to revise the curriculum in parallel with the onset of this training program and a few even expressed appreciation at the opportunity to be involved in such a momentous activity.

As the training has progressed, I also realized that having the GTAs reflect on what they already knew was the most powerful tool in empowering them and building their confidence as evaluators, especially for ESL GTAs. Like Weiler (1988, p.13), I see this phenomenon as related to Gramsci's ideas about the importance of raising consciousness about one's position to recognize one's own power to transform the system. In the case of my research, that means dispelling the myth that non-native English-speaking GTAs are incapable of teaching technical writing through feedback because of their alleged lack of language skills. This realization leads to my second conclusion: Culture and language ability had little bearing on whether a GTA provided effective feedback to students. Since most of the GTAs were from outside the United States, most often from India and China, one might have expected cultural differences to become points of conflict. However, language and culture proved to be less important to GTA performance than their perception of the value of their efforts as evaluators. From the interviews and round-table discussions, it seemed that GTAs who viewed their students more positively (as being willing to put forth the effort to learn) were more likely to provide the most effective feedback. GTAs who characterized their students as lazy or dishonest were less likely to put forth as much effort. I saw no correlation between GTA performance and culture or language ability. In fact, three of the most effective GTAs overall, in terms of their level of written feedback, teaching evaluations, and instructor observations, spoke English as a second or third language.

Transitioning to the new curriculum: Building on what we learned

The new curriculum was developed in parallel with this training program, and, since all of the members of the lab teaching team were on the curriculum revision committee, we were able to solicit feedback from the GTAs about ways to redesign the courses to better meet students' needs. The three original labs and a few theory courses were eliminated and a new four-course mechanical engineering practice sequence was implemented, along with two key changes suggested by the GTAs. The first suggestion was to include much more emphasis on technical communication and start that instruction earlier in the curriculum. As an example, Eli said many of his students struggled with the concept of audience in writing their reports, especially if they were told to write a report for a specific audience such as a supervisor where they needed to understand the level of formality and detail needed. To address this concern, a series of seventeen communication modules was developed for the four-course sequence, using Paul V. Anderson's textbook *Technical Communication: A Reader-Centered Approach* (2015), an approach that builds on the concepts of audience introduced in First Year Composition. The modules allowed for scaffolding communication instruction, beginning with the basics in the first course and moving to more complex issues such as cultural communication in engineering in the final course.

The second suggestion was to replace some of the lab reports with memos, technical papers, and other kinds of written assignments as well add in some more presentations. The teaching team recognized that traditional lab reports were only useful formats for students planning to attend graduate school and eventually write conference and journal papers, so instructors were open to working with me to develop a variety of assignments. John Bean's Engaging Ideas: The Professor's Guide to Integrating Writing, Critical Thinking, and Active Learning in the Classroom (2011) proved to be a great resource and sparked discussions about crafting assignments that challenged the students but also did not burden the GTAs and faculty with too much grading since these courses have large enrollments (between 80 and 260). These ME Practice courses are the subject of current research on the effectiveness of project-based learning, the use of portfolios for self-assessment, and the effect of self-reflection on perceived skill attainment and mastery. Thus far, student feedback on the new courses has been positive. Feedback from students regarding the lab GTA training program is the subject of the next chapter.

Chapter Four: The Student Perspective

One qualitative aspect of my research is a survey consisting of seven open-ended questions seeking feedback from students in MEEM 3220 Energy Lab and MEEM 3000 Mechanical Engineering Lab. This survey (see Appendix D) spanned six semesters–fall 2012 through spring 2015–and had a response rate of 74 to 95 percent. The survey collected information about the quality of feedback students received. It also explored the effectiveness of detailed guidelines for writing the reports and the corresponding rubric implemented to improve grading consistency and student learning. The responses were analyzed using thematic analysis, a qualitative research method of textual analysis. This chapter describes the theoretical foundation, structure, and results of that survey. I first discuss the literature on student evaluations of teachers and their methods and the theoretical foundation of thematic analysis. Next, I present the survey results in two subsections, teaching tools and feedback, based on the two distinct sets of questions asked of the students. Then, I discuss what the teaching team learned from this survey and how that information was applied. Finally, I discuss how thematic analysis might be used to further engineering education research, especially in large enrollment courses.

Before discussing thematic analysis, I will briefly explore the literature on student evaluations of teaching, which this survey resembles in the sense that I asked students to evaluate their GTAs based on two criteria: 1) effective use of the guidelines and rubric and 2) effectiveness of the feedback provided.

Student Teaching Evaluations

Much research has been done on the effectiveness and validity of teaching evaluations, as summarized by Marsh (1984). While the survey presented in this case is not a traditional teaching evaluation per se in that it does not use the Likert scale rating system, it does measure certain aspects of standard student evaluations of teaching. For example, the survey asks students to consider two aspects of teaching effectiveness–the feedback the GTAs provide on the lab reports and the consistency with which the GTAs grade the lab reports using the guidelines and rubric. Marsh notes that while student evaluations of teaching effectiveness have value, they should be used in concert with other forms of assessment (1984, p. 748), which is one reason I chose to use an open-ended-question survey instead of a rating system such as the Likert scale. By allowing the students to write extended comments for each of the seven questions, I was able to collect a set of data rich in context, with more detail than a rating system.

Student evaluations of teaching do more than just tell us about the performance of an instructor and, in this case, the usefulness of some course materials; they can also guide improvements in the overall student/instructor experience. While this survey is not designed to evaluate the effectiveness of particular GTAs, it does provide a snapshot of how, or whether, the training's effectiveness changed over time. Marsh and Roche argue that for student evaluations of teaching to serve the purpose of improving the effectiveness of teaching, the results must not only be shared with the instructor, but put into context with the mean results from other instructors and courses (1997). Use of such norms "helps teachers to determine their relative strengths and weakness, because raw scores on different factors are not directly comparable" (p. 1194). One of the purposes of this survey was to help guide improvements in the training based on student feedback about what worked and what did not in terms of their GTA's teaching and feedback methods. As an example of how the results can help us improve instruction, Kulik and McKeachie note that highly rated instructors tend to be effective communicators (1975, p. 219). In response to this survey, several students either commented on a need for increased communication about expectations and interpretations on the part of the GTA or specifically cited this quality as a strength of his or her GTA. Based on this feedback, instruction on ways to incorporate such communication into weekly lectures has been added to the training.

Additionally, while some researchers have explored the effect of student perceptions and characteristics on their evaluations of their instructors (Kulik and McKeachie, 1975; Worthington, 2002), this survey does not record the student's identity. However, the average BSME disciplinary course demographic is 95 percent Caucasian and 90 percent male (MTU Institutional Analysis website). Due to the large class size and average response rate of about 85 percent across both courses all six semesters, it is fair to assume the demographics of the two courses surveyed closely matched the general program demographic. Also, one aspect that must be factored into the survey responses is conditions under which the teaching occurred, such as whether the course is required or an elective. Gage (1961) analyzed student ratings within the College of Education at the University of Illinois and found that instructors in lower level courses were generally rated lower than advanced courses and that instructors for required courses were generally rated lower than those of elective courses. MEEM 3220 and MEEM 3000, both required courses, are unpopular due to the volume of work (twelve lab reports due during the 14-week semester) for just one credit. As will be noted in the results section, this issue might account for some of the comments regarding harshness of grading and concerns about timeliness of feedback.

It is also important to remember that GTAs could be considered novice teachers, with little to no experience in classroom management or evaluation beyond their own experiences as students. Berliner (1988) states that at this stage, "the commonplace must be discerned, the elements of the task to be performed must be labeled and learned, a set of context-free rules must be acquired" (p. 40). The GTAs are new to the language of writing evaluation and, if they did not participate in lab courses as undergraduate students, they must also learn the structure and content of a typical lab report. The teaching team for the three labs[16] considered in the broader research project have found that it usually takes two to three semesters for a GTA to be fully competent at evaluation and comfortable in providing basic guidance in technical communication. One GTA, who struggled with evaluation in his first two years, recently took the initiative to develop and provide a lesson in collaborative writing to all of the students in his current course, ME Practice II. He saw the need and addressed it without any prompting from the teaching team, a step he would not have taken a year earlier. In addition to building experience and confidence over time, this GTA benefitted from seeing the students' responses to the survey and hearing my interpretations of their responses using thematic analysis, which is explained in the next section.

---

[16] MEEM 2500 Industrial Design and Manufacturing was not included in the survey, the reason for which will be explained later.

Thematic Analysis

Boyatzis (1998) describes thematic analysis as "a process for encoding qualitative information. The encoding requires an explicit 'code.' This may be a list of themes; a complex model with themes, indicators, and qualifications that are causally related; or something in between these two forms" (p. 4). Themes are patterns to be discerned from the data that provide context to the information. In a codebook, each theme includes the following:

- a label
- a definition of the theme
- a description of how to recognize the theme
- a description of qualifiers or exclusions in determining whether a piece of data fits the theme
- examples of positive and negative responses that would fit the theme.

This method reflects the three-stage analytic cycle described by Bendassolli (2013), which includes careful examination of the student responses, creation of a codebook based on themes and patterns that emerge, and finally the categorization and conceptualization of those themes and patterns in comparison to relevant theories and findings in the literature. The process of determining whether a response fits into a particular theme requires interpretation on the part of the researcher, an admittedly subjective process. Crabtree and Miller (1999) describe interpretation as "a complex and dynamic craft, with as much creative artistry as technical exactitude, and it requires an abundance of patient plodding, fortitude, and discipline" (p. 128). Thematic analysis can be used as a first step to understand a phenomenon (Morphew and Harley, 2006).

Validity issues, sometimes a concern expressed about qualitative research, can be addressed by developing a template (Fereday and Muir-Cochrane, 2006) and/or having multiple people code the data individually (Boyatzis, 1998, pp. 144-145). In the case of this assessment, I was the sole reviewer, but I shared results with the teaching team and GTAs and routinely discussed the validity of the comments as well as the analysis. Additionally, being the sole reviewer afforded me the opportunity to "live" with the data and develop a holistic understanding of the students' concerns in the context of both the course and the BSME program. For example, many students made comments (positive and negative) about instruction in general in the department, which helped me as I worked with faculty designing the new curriculum.

One benefit of examining student surveys using thematic analysis is that it forces researchers to "go beyond induction" by developing "a theory that is not a simple synthesis of observational statements" (Bendassolli, 2013). While this method does not rule out use of scaling or scoring themes to provide an overall description of results or confirmation of those results (Boyatzis, 1998, p. 160), this process of analysis helps develop a deeper understanding of the data. This means I can justify that what I observed about the data was grounded in objective investigation, i.e. others would likely draw similar conclusions from an examination of the data in question. Given that engineering educators are usually trained to value deductive, empirical research, applying such rigor to qualitative research can make results more acceptable for reviewers in the field (Baillie and Douglas, 2014).

Avoiding Common Pitfalls of Thematic Analysis

Boyatzis describes two major types of challenges in using thematic analysis–personal and disciplinary. Under the personal category fall issues like time commitment (it can be a very time-consuming process) and the possibility of not making any scholarly discoveries because no patterns reveal themselves. It took me about forty hours per survey per course per semester to process and analyze the data. The most time-consuming aspect was reading each response and determining which code or codes to assign. Related to this issue is that the researcher must be prepared to rework themes, combining and pulling out themes for the most effective analysis. I found that once a theme was established, it was often necessary to break that theme into sub-themes or to create a new theme if there was enough differentiation in responses to warrant it. This is why thematic analysis is an inductive process, requiring some personal experience and "intuition" on the part of the researcher. Being so immersed in the data has brought me in touch with student concerns about their writing and learning styles in a way that would not be possible if I were to bring in other coders to help process the results.

Being this "close" to my data, though, brings up a concern in the disciplinary category, which is whether I can translate my results into something usable for the broader community. With the increasing interest in qualitative research applications to engineering education, I make the case for using thematic analysis to develop a deeper understanding of issues such as student retention, reflecting on learning and diversity initiatives, and self-assessment. Because the survey was conducted over six semesters, I have been able to make some valuable discoveries longitudinally about issues such as whether the evolution of the training improved the students' experiences over time and whether consistency in grading between GTAs improved, especially in MEEM 3000[17] (it did not). Additionally, while being able to interpret and categorize the information is the key to success with thematic analysis, the researcher must take care to be faithful to the respondent and recognize that each of us has biases. This means avoiding trying to "read" the respondent's mind. If the person did not say something the way the researcher expected, one should not try to make the data fit a particularly bias, a concern related to validity, addressed in the next section.

Validity in Qualitative Education Research

I am including a brief discussion of validity of qualitative research methods here because such methods are a recent phenomenon in engineering education (Baillie and Douglas, 2014). Eisenhart and Howe define validity "as the trustworthiness of inferences drawn from data" (1992, p. 644) and note that the emergence of qualitative studies in education research in recent decades has challenged traditional, empirical notions of validity. They describe five standards for validity in qualitative education research that I applied (pp.657-663):

Data collection: "The data collection techniques employed should fit, or be suitable for answering, the research question entertained. … [R]esearch questions should drive data collection techniques and analysis rather than vice versa." The survey questions are directly related to my research question regarding the effectiveness of the training in helping GTAs provide feedback that promotes learning.

---

[17] MEEM 3000 was notorious among students because of inconsistent grading between the three GTAs assigned to the three different subject areas covered in the course.

Application: Data collection and analysis techniques must be competently and effectively applied, following established protocols for the technique in question. As noted in the previous discussion of thematic analysis, I used an accepted, and well-used, method to analyze the results of the survey to reach conclusions.

Assumptions & goals: "… the assumptions and goals embedded in the development and conduct of the study must be exposed and considered." The assumptions and goals of this study were explained in detail in Chapter Two, which focuses on the GTA training program's theoretical foundation and structure.

Value constraints: External and internal value constraints must be applied. "External value constraints concern whether the research is valuable for informing and improving education practice–the 'so what' question. … Internal value constraints refer to research ethics … [or the way] research is conducted vis-à-vis research subjects." I discuss the internal value of the study throughout and address the external value at the end of this chapter and in chapter six.

Comprehensive: The study should be comprehensive in that it "balances design quality and importance against risks and permits the robustness of conclusions to be assessed." As noted in chapter one, this study includes multiple methods of assessment to reach a comprehensive understanding of the program's effectiveness. Note that validity is also addressed in Chapter Five as it relates to assessing student work.

In the next sections, the results of the survey are presented and analyzed.

Survey Results: Students evaluate the tools and GTA feedback

In this section, I discuss the results of the seven-question survey (Appendix D) given in the MEEM 3220 Energy Lab and MEEM 3000 Mechanical Engineering Lab courses. 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 whether the GTAs followed the lab report guidelines and rubrics in evaluation and whether those tools helped their learning. 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 (Figure 3 on page 93).

Additionally, several responses to each question were excluded, as shown in Figure 4. The main reasons for exclusion were because: 1) an error was made when the survey responses were formatted by the GTA, 2) it was not clear what the student was trying to express, or 3) the answer had no discernable connection to the question asked. Grice refers to this last instance as an implication, meaning that the student likely understood the question but did not want to respond to it as worded (2013, pp. 54-55). Instead, the student might have responded to a question he or she wished was on the

Enrollment and Response Rate Data			
Course/Semester	Enrollment*	# of Responses	Response rate
3220 Fall '12	100	92	92.00%
3220 Spring '13	83	71	85.54%
3220 Fall '13	124	110	88.71%
3220 Spring '14	102	75	73.53%
3220 Fall '14	133	121	90.98%
3220 Spring '15	147	113	76.87%
3000 Fall '12	116	110	94.83%
3000 Spring '13	93	86	92.47%
3000 Fall '13	103	90	87.38%
3000 Spring '14	100	84	84.00%
3000 Fall '14	113	97	85.84%
3000 Spring '15	119	101	84.87%

*Enrollment in course at the end of the semester, excluding students earning a "W" grade.

Figure 3 Enrollment and response rate data for both courses for all six semesters of the survey.

survey. In Figure 4 on page 94, we see the number of responses excluded varies significantly from course to course and question to question. For example, in the case of question one, the first response in each section of MEEM 3220 in fall 2013 was inadvertently deleted by the GTA and, by the time the error was discovered, the original data was lost. Also in MEEM 3220, I suspect that students in the spring 2015 semester might have received confusing instructions regarding the meaning of question three because nineteen responses had to be excluded for lack of clarity.

Responses to the seven questions were categorized into between thirteen and fifteen themes unique to each question. A listing of each theme for each question is in Appendix E. These themes were then grouped into broader categories to facilitate discussion and analysis for this chapter and are shown in Figure 5 on page 95. For

# of Responses Excluded		
Question	MEEM 3220	MEEM 3000
1	45	5
2	4	4
3	26	4
4	5	6
5	4	7
6	19	25
7	17	12

Figure 4 Total number of responses excluded for each question in each course.

question one on the lab report guidelines, there were four categories–yes, the guidelines improved understanding; yes, in tandem with feedback and/or the rubric; no, the guidelines were not helpful; and issues with the GTAs not following the guidelines consistently. Categories for question two on the rubric were similar to question 1. Categories for questions three and four on grading consistency with the guidelines and rubric respectively were also consistent with each other, with three groupings–yes, grading was consistent with the tool in question; no, grading was not consistent; and issues with GTAs' not following the tools or inconsistencies between GTAs. Responses to question 5 regarding whether the GTA's feedback helped them learn fell into three broad categories–yes, it did help; no, it did not help or the amount and quality of feedback varied too much between GTAs or from week to week; and issues with feedback not being provided, feedback that was too vague or came too late, or placed in a location where students did not know how to access it.

Some of the most valuable responses came from questions six and seven, which sought input about how to improve the guidelines and rubric (q. six) and the GTAs; feedback (q. seven). Responses to question six were grouped into five broad categories–

Q. 1 Did the guidelines improve your understanding of the requirements for the lab reports? Why or why not?			
Groupings	MEEM 3220 responses	MEEM 3000 responses	Theme
Yes	356	303	1, 2, 4, 9, 12, 13 ,14
Yes, in tandem with feedback and/or rubric	42	26	7, 10
No; Too vague	91	77	3, 5, 6, 15
GTA did not follow; Discrepancy between GTAs	12	72	8, 11
Excluded: MEEM 3220 = 45 MEEM 3000 = 5			
Q. 2 Did the rubric improve your understanding of the requirements for the lab reports? Why or why not?			
Yes	391	230	2, 6, 10, 11, 12, 15
Yes, in tandem with guidelines, lab manual, and/or feedback	61	77	1, 3, 7, 14,
No, not enough detail; hard to follow; did not use	99	135	4, 5, 8,
No, GTA did not follow; Too much discrepancy between GTAs	34	70	9, 13
Excluded: MEEM 3220 = 4 MEEM 3000 = 4			
Q. 3 Was the grading consistent with the instructions in the guidelines? If not, please describe any inconsistencies?			
Yes	428	298	1, 2, 4, 5, 13
No	19	15	10, 11, 12,
GTA did not follow; Too much inconsistency between GTAs; inconsistency from week to week	92	265	3, 6, 7, 8, 9,
Excluded: MEEM 3220 = 26 MEEM 3000 = 4			
Q. 4 Was the grading consistent with the rubric? If not, please describe any inconsistencies.			
Yes	490	333	1, 4, 5, 7, 11, 14
No	69	71	2, 9, 10, 13,
Too much inconsistency between GTAs; GTA did not follow; GTA did not review report thoroughly; grading too harsh	45	178	3, 6, 8, 12,
Excluded: MEEM 3220 = 5 MEEM 3000 = 6			
Q. 5 Did the GTA's feedback on the lab reports help you learn, e.g. did you have a better understanding of the expectations after reviewing the GTA's feedback?			
Yes, when it was provided	413	363	1, 2, 4, 8, 10, 11,
No, amount and quality of feedback varied between GTAs	11	82	3, 6, 14,
No feedback provided or feedback too vague, or came too late, could not find it	162	172	5, 7, 9, 12,13, 15
Excluded: MEEM 3220 = 4 MEEM 3000 = 7			
Q. 6 What improvements would you suggest to make the guidelines/rubric more effective?			
More detail needed	188	182	1, 8, 9, 10, 11,
More consistency needed between the two tools and/or lab manual instructions	68	81	2, 3, 15
Require GTAs to follow the guidelines/rubric and/or explain their interpretation	69	142	4, 5, 13, 14,
Increase flexibility in grading options on rubric	42	38	6, 7,
No improvements needed	190	87	12
Excluded: MEEM 3220 = 19 MEEM 3000 = 25			
Q. 7 What improvements would you suggest to make the GTA feedback more effective?			
More detailed feedback	224	292	1, 2, 3, 4, 7, 8, 13,
More timely feedback	62	75	12
Make feedback easier to find	69	72	5, 14,
Change grading policy to allow for resubmission or more lenient grading	31	80	9, 10, 11, 15
No improvements needed	194	72	6,
Excluded: MEEM 3220 = 17 MEEM 3000 = 12			

Figure 5 Questions, theme categories, and response frequency

more detail needed; more consistency needed between guidelines, rubric and/or lab manual; more emphasis needed on requiring GTAs to follow the tools and/or explain their interpretation; increased flexibility in grading options on rubric; and no improvement needed. There were also five broad categories for question seven–more detailed feedback needed; more timely feedback; make it easier to find the feedback; changes needed in grading policies; and no improvement needed.

The next subsections discuss responses to each question in detail. Since the survey was designed to help the teaching team understand students' perceptions of the tools and the feedback provided by the GTAs, the results are presented in two subsections–teaching tools and GTA feedback.

Guidelines and Rubric Questions: Usefulness to Students in Learning and Evaluation

Questions one through four and question six address 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 hypothesis 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 actually improved consistency compared to semesters prior to implementing the training.

Question 1 responses: Of the fifteen themes in question one, four distinct categories emerged:

1) The lab report guidelines did indeed improve their understanding of the requirements for the lab reports.
2) The guidelines were helpful in conjunction with feedback and/or the rubric.
3) The guidelines were not helpful in learning, often because the guidelines were seen as too vague.
4) GTA interpretation issues such an apparent disconnect between what the guidelines called for and how the GTAs interpreted those instructions.

Responses from each course are summarized in blue graphs for MEEM 3220 and orange graphs for MEEM 3000 beginning on the next page with Figures 6 and 7. Each figure summarizing the question responses includes the ways in which the various themes were grouped into larger categories, which is explained at the beginning of each questions sections. The numbers of students responding represents the larger grouping. As discussed in Chapter Six, one issue with using thematic analysis with such a large population is that the data can quickly become overwhelming unless it is grouped and regrouped. Figure 5 represents the same information collected in one graphic, with exact numbers and themes in each category for each question.

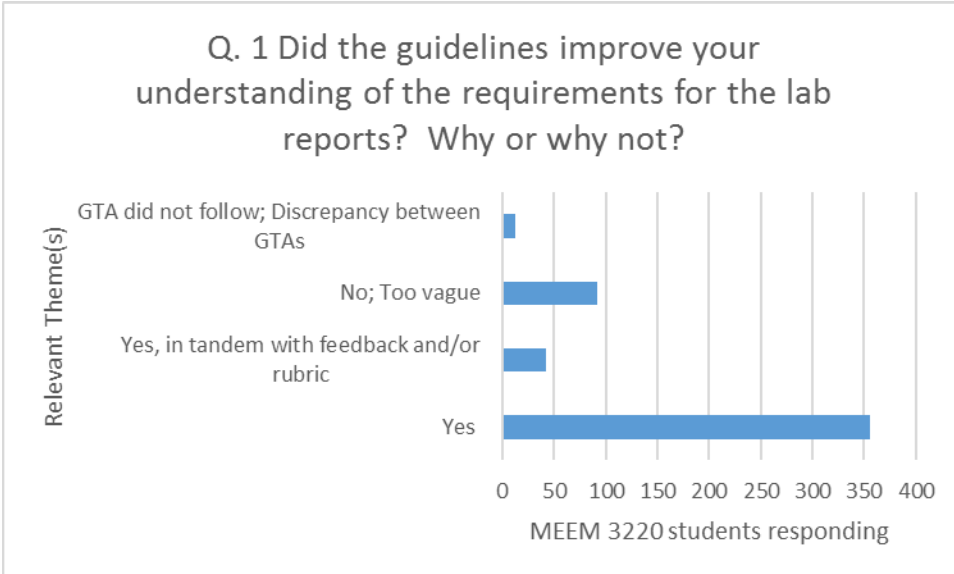

Figure 6 Question 1 responses from MEEM 3220

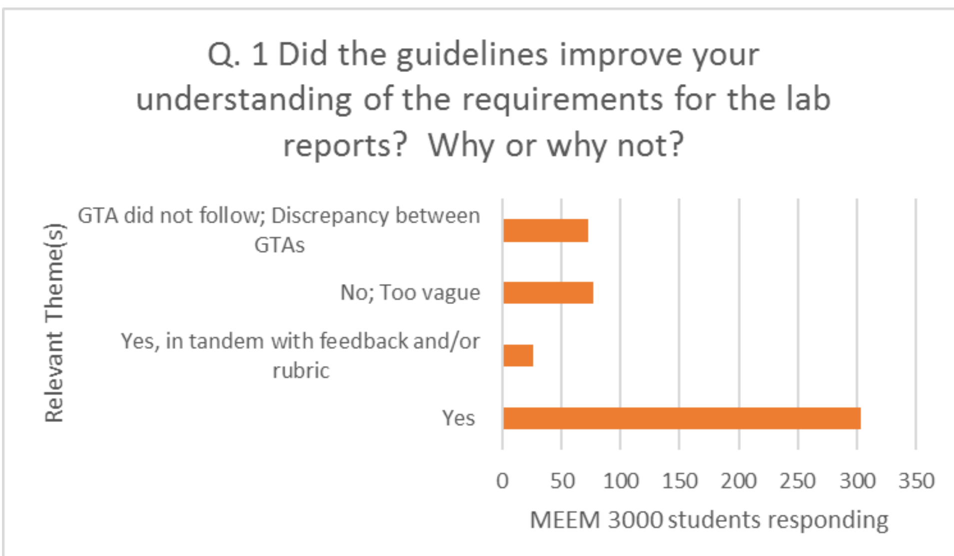

Figure 7 Question 1 responses from MEEM 3000

<u>Lab Report Guidelines Were Helpful on Some Level</u>–Seven of the themes fell under the category of some variation on helping the students improve their understanding

of the lab report genre. Student 17[18] from the fall 2014 MEEM 3220 course stated that "the guidelines were very useful. They told us exactly what was expected in each section of the lab report, but still left us with enough freedom to make each section more personalized. … This made it easier for me to make the lab report in a way that made sense to me, which is how we will write in the real world." Another student (18) in the same section of that course used the guidelines as a writing prompt, which we had never considered as a possibility, stating, "Whenever I was concerned with what to provide in the report, I could always use it as a crutch to get ideas moving."

Guidelines worked in tandem with the rubric or lab manual–A small subset from each course specifically mentioned using the guidelines in tandem with the grading rubric and/or their GTA's feedback to improve future lab reports. Also, while the guidelines did not contain instruction in any engineering science concepts, the lab manual did include "refresher" information.

Some Students Found Guidelines Too Vague–Not everyone found the guidelines useful, though, as indicated by about a quarter of the students in each course. The most common reason cited was that descriptions of the content expected in each section were too vague. However, in reviewing many of the responses in this theme, students in MEEM 3220 often confused the lab report guidelines with the lab manual for the course, which outlined the requirements for each lab in terms of the concepts covered and data to be collected. For example, student 77 in the fall 2014 semester stated, "Yes, I love this lab but the lab guidelines can be really confusing some times. Data analysis parts needs

[18] Students responded to the survey anonymously so I numbered each line of responses to differentiate between students.

[sic] to be explained more clearly. It is good chance to use fluid Mechanics and Thermodynamics in real life. It's a good review for those courses."

Issues With How GTAs Used/Interpreted the Guidelines–The only discrepancy in responses between the two courses was related to the GTAs either not using the guidelines themselves in evaluation or the GTAs interpreting them differently, a problem cited primarily by MEEM 3000 students. Student 7 in the MEEM 3000 fall 2012 semester thought the issues with interpretation had to do with a lack of familiarity with the guidelines. "The initial guidelines were too vague and the understanding the TAs had of them did not help. As the semester progressed they improved. Overall I feel that as they are the guidelines are still a little bit too much open to interpretation, and that this has led to some significant discrepancy in grading between the various TAs." This might be a fair assessment as fall 2012 was the first semester we used the guidelines, except the number of students citing this as a problem actually increased in subsequent semesters. In fact, the fall 2014 and spring 2015 semesters had the most students responding with this concern. In discussions with one of the MEEM 3000 course instructors, I learned that one GTA was a particularly harsh grader relative to the other two GTAs, despite two grade-norming sessions and at least two meetings with the instructor regarding his interpretation of the guidelines and rubric. This GTA moved to a graduate research assistant position the following year, thereby "solving" the problem.

Question 2 responses: Results for question two regarding the rubric's usefulness in learning were similar to those for question one except that fewer students in MEEM 3000 (Figure 9) found the rubric helpful. Again, this issue seems related to the GTAs' use of the rubric. Also, more students in MEEM 3000 indicated concerns about the points spread in the rubric, something over which I had no control and that faculty chose not to address. Student 2 in the spring 2013 course summed it best by stating, “The rubric was helpful to my understanding for all clarifications between the grades but not the difference in between the top score grade and the 2nd best grade. It is not always apparent as to why I fell into the second bracket. I think it would be helpful to have room for additional details on the rubric from the TA's review.”

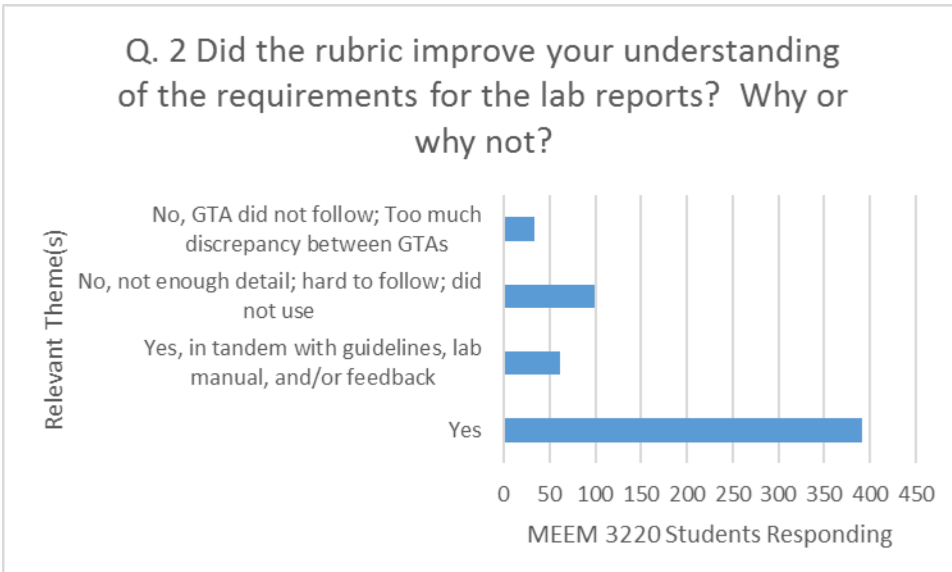

Figure 8 Question 2 responses from MEEM 3220

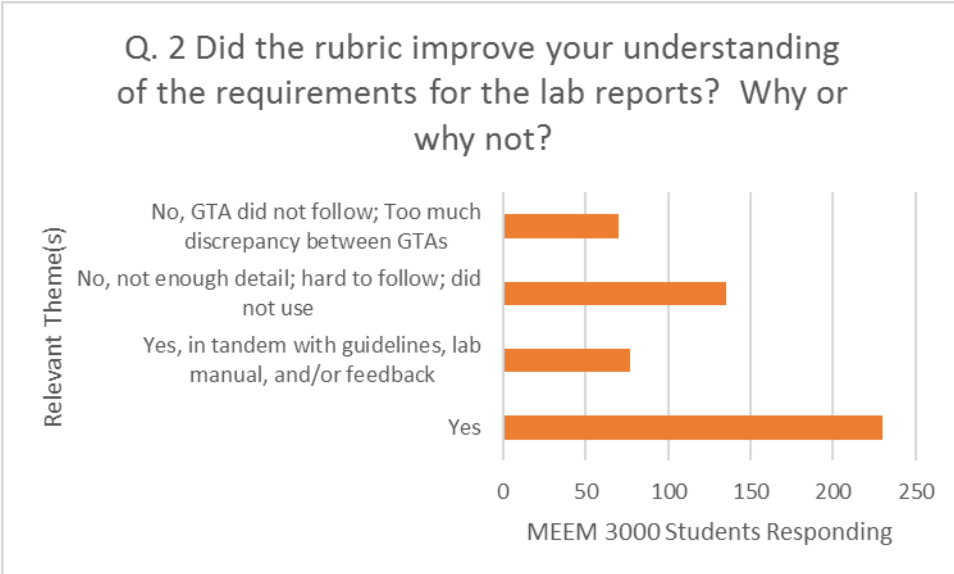

Figure 9 Question 2 responses from MEEM 3000

Question 3 and 4 responses: Since the responses to questions three and four were similar and both questions were related to evaluation, I will discuss them together. While most students said grading was consistent with the guidelines (Figures 10 and 11) and rubric (Figures 12 and 13), there were again significant differences between the two courses, which is not surprising considering that the responses to the first two questions showed discrepancies between the Energy Lab and Mechanical Engineering Lab courses. Student 4 in the spring 2015 MEEM 3000 course captured most vividly the frustration many students felt with the following statement (emphasis provided by the student):

> "HAHAHAHAHAHAHAHAHAHAHAHAHA NO. Each TA wanted something entirely different. One wanted pictures, one wanted block diagrams, one didn't like chunks of data in the body, the other wanted all the data in the body of the report. It was wholly inconsistent, and frankly one of the most asinine class set ups I've ever experienced."

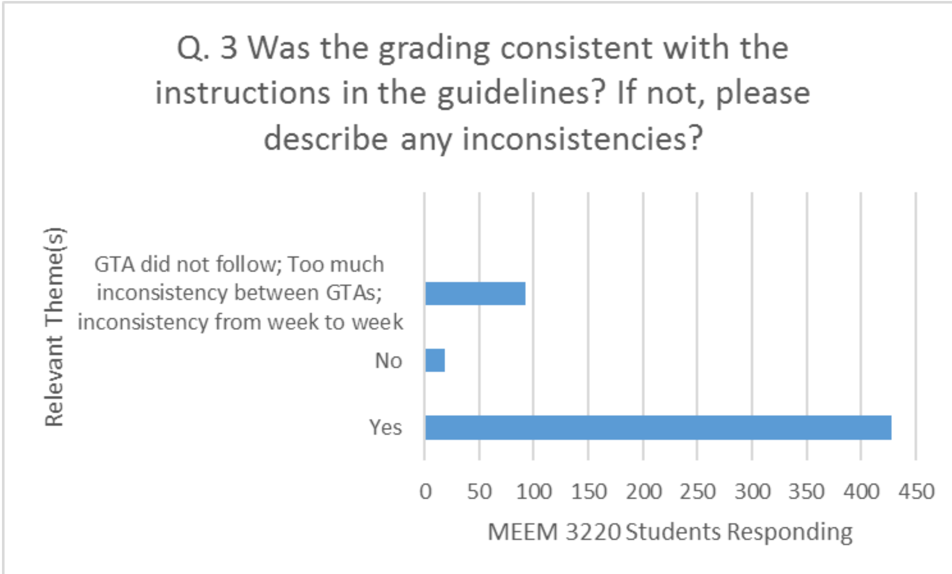

Figure 10 Question 3 responses from MEEM 3220

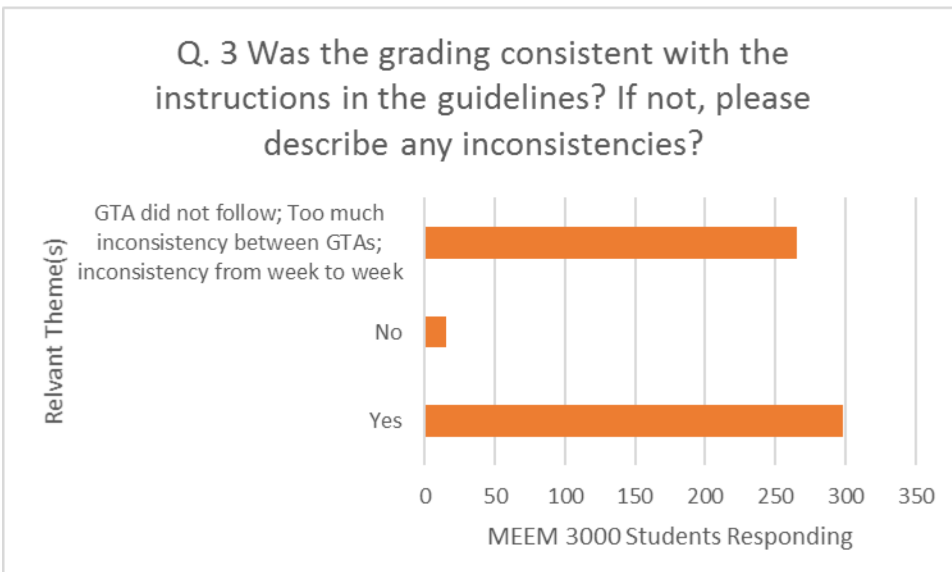

Figure 11 Question 3 responses from MEEM 3000

As noted earlier, the issue of inconsistent grading in MEEM 3000 was never resolved during the six-semester study and was not a factor in MEEM 3220. It is important to note that the lead GTA for MEEM 3220 in fall 2012 and spring 2013 customized the rubric so that the analysis section matched the deliverables outlined in the lab manual for each lab. This provided more detailed guidance to both the students and their GTAs. The lead GTA was able to take this initiative with relative ease because he had recently rewritten and further developed the course lab manual. Such a step was never taken in MEEM 3000 so the rubric used in that course was much more generic, a fact that did not go unnoticed by students who took MEEM 3000 in later semesters and requested that such a detailed rubric be developed for each lab in that course as well.

One other minor concern was that a small subset of students felt there was too much focus on formatting in the grading. Since these students tended to be grouped in the same section and course, this indicates an issue with just a few GTAs. Student 7 in the spring 2014 semester of MEEM 3220 stated:

> "The grading scheme was focused too much on the nit-picky details and not on the understanding of the concepts. Honestly on some labs you cloud [sic] have gotten an A from just knowing about the technical writing and regurgitating of information, no learning of the concepts would have been required to get the grade. More of the grade should have been based on the demonstration of learning the concepts. I know report formatting and official reports are important, but I feel like these skills would still be learned even if the grade focus was more on the learning of the material."

Even though there were just 25 such responses total across all six semesters of both courses, I have made it a point to continually impress upon the GTAs that feedback and grading should focus on content, not formatting.

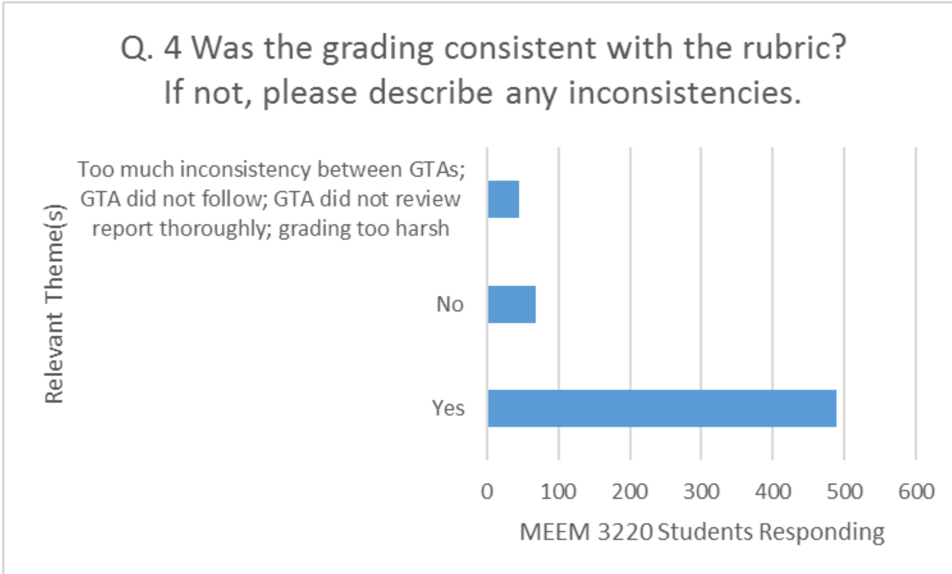

Figure 12 Question 4 responses from MEEM 3220

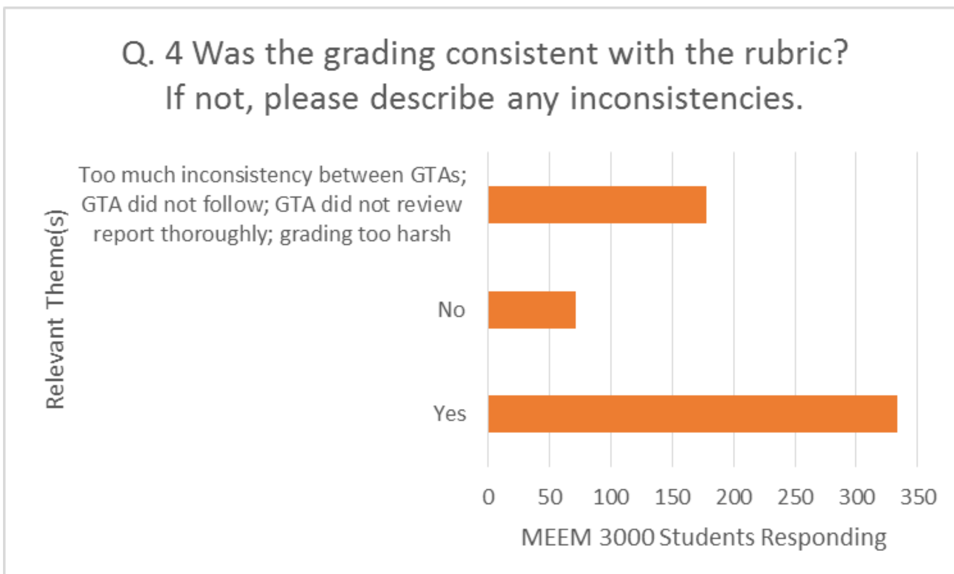

Figure *13 Question 4 responses from MEEM 3000*

Question 6 responses: Five major themes emerged from the responses to question six regarding ways to improve the lab report guidelines and the rubric:

1) More detail needed in one or both the tools;
2) Increased flexibility needed in grading options on the rubric;

3) Require GTAs to follow the guidelines/rubric and/or explain their interpretation;

4) More consistency needed between the two tools and/or lab manual instructions;

5) No improvements needed.

Figures 14 and 15 show the breakdown of responses for each course.

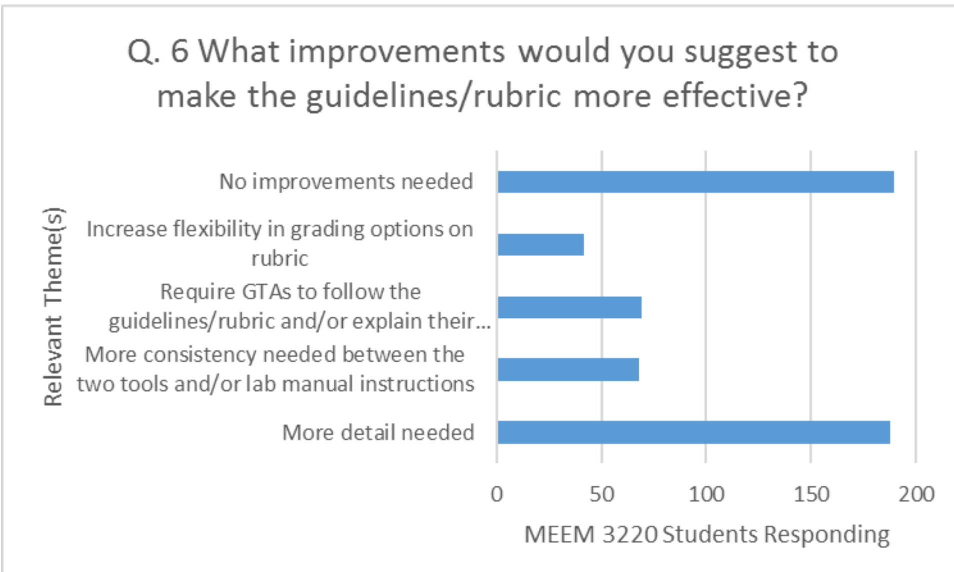

Figure 14 Question 6 responses from MEEM 3220

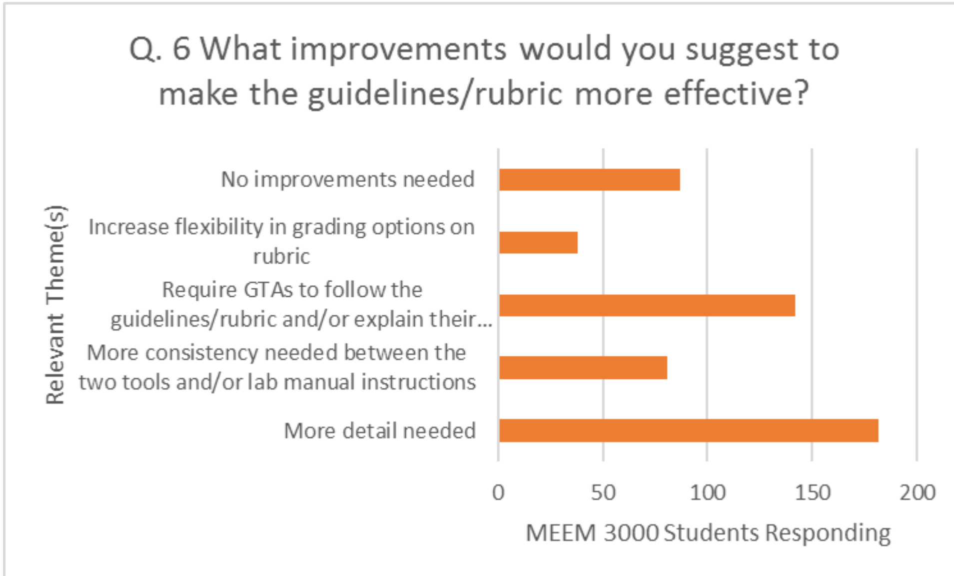

Figure 15 Question 6 responses from MEEM 3000

<u>More Detail Desired in the Guidelines/Rubric</u>–The majority of responses from students in MEEM 3000 and nearly half of those in MEEM 3220 focused on a desire for more detail in the explanations provided in the guidelines or rubric. Students used words such as detail, explanation, clarify, and clarification, along with words like include or add. Some students were looking for specific information to be in the guidelines, such as Student 6 in the fall 2014 MEEM 3220 course who stated that the "guidelines could include what styles of writing to use, whether it be in first or third person. Being specific as to which tense (past/present) to use in the report would help with the continuity of each individual report." Others wanted more detail in the rubric, such as Student 4 from the fall 2012 MEEM 3220 course, who said, "The only thing that would make the rubric more effective is to make each entity more detailed so that there are less areas of ambiguity when reading the rubric." As noted earlier, this was done for MEEM 3220, beginning with the spring 2013 semester.

The last comment above is interesting, however, because the guidelines were intended to be the *first* point of reference for students and included explanations of the nature of the content of each section and provided some tips on composing reports such as designing graphics and writing concise sentences. At ten pages long, though, perhaps the guidelines were considered too long to refer back to on a regular basis. In later semesters, the GTAs developed quizzes based on the content in the guidelines as a way to ensure students reviewed them at least once. We have to be careful not to infer too much from each response. Based on the fact that so many students specifically cited they wanted to see more detail in either the guidelines or the rubric, though, it might be fair to say many students felt they did not have enough preparation going into the courses to compose technical content with confidence.

Within this category, students provided some great suggestions for additional features to aid learning. These idea fell into three subthemes–location of the guidelines or rubric, include additional sections, and include sample reports. Eight students indicated they would like to see guidelines and rubric either included in each week's lab experiment manual or provided in hard copy. Both tools were posted as separate files on Canvas and students were expected to view them and download them from the learning management system. However, some of the students said they had trouble finding them on Canvas. For example, Student 28 in the fall 2012 MEEM 3220 course stated, "The sample lab report and guidelines should be printed and given to the students so they don't have an excuse not to use them. Or at least email them out. Lots of people had problems viewing or finding them."

As far as adding sections to the guidelines, a few students asked that formatting requirements be included and one thought the background and objectives section should be split into two section in the guidelines. While it was not clear what the second student was seeking, the teaching team did include complete formatting instructions for the spring 2013 semester because several students expressed concern about formatting in response to questions one and three. In light of student responses in later semesters decrying the emphasis on formatting, though it is possible that the less experienced GTAs latched onto the formatting instruction for ease of grading.

A popular request from students was to include an example lab report in the guidelines or to review one that would score well during a class period. One hundred and fifty-one students made this request, with one saying, "… I think a well put together lab report for a student-level lab would be greatly appreciated to knowing what should and should not be in a lab." As noted earlier, while some GTAs chose to provide their students with a sample lab report, the GTAs are now instructed to review a well-written lab report with the students, providing insight into how the GTA interprets the guidelines and rubrics so that students understand the expectations and have something to model. Additional instruction in class is necessary because simply providing a sample lab report without discussing the context of the content has not proven an effective learning tool in other MEEM courses. A technique that worked for one GTA was to review a sample lab report in class using the rubric. Another faculty member would have students use the rubric to evaluate their own reports and submit their "grade" along with their report. This practice proved to be effective at encouraging students to review the rubric and ask questions about areas of confusion *before* they turned in their work.

Increase Flexibility in Rubric Options–One hundred and sixteen students expressed the opinion that the GTAs needed to have more flexibility in the way in which points were awarded based on the rubric. While the rubric had five possible grading options overall (Excellent, Good, Acceptable, Poor, Incomplete), not all sections had all five options. For example, the title page could be rated as either Excellent or Incomplete because it was not possible to further define the quality of the section. Either it was done correctly or it was not. The points scale was built into the rubric on Canvas so the TA could not override the system and award a different score. The problem was that if the section was worth 10 points, the student could lose three points for missing just one element deemed necessary. For example, Student 10 in the fall 2012 MEEM 3220 course stated, "I like what the rubric has to offer, but I would suggest letting the TA put the grade and not have to pick whether or not its [sic] acceptable or incomplete, which are the only options." This issue raises a valid concern about rubrics being tied to a specific points structure–the loss of flexibility on the part of the grader to assign a points value based on his or her own personal judgment. The other side is that such a strict point structure may improve consistency from TA to TA, one of the overall goals of the program.

Allow for Revision/Resubmission–A few students expressed interest in being able to revise and resubmit reports to earn back points, which was the final subtheme in this category and also showed up again in responses to question seven. I included the following comment from Student 54 from fall 2012 MEEM 3220 because, although just four students mentioned it, revision is a key component of the composition learning process (Faigely and Witte, 1981), which this student recognized. "… allow for resubmissions. It would force the students to learn what is needed and they would be rewarded with a better grade." Due to the already-heavy grading load, the teaching team did not find an effective means of incorporating revision into either MEEM 3220 or MEEM 3000 courses, although it was part of the MEEM 2500 lab. As assignments are developed for the new curriculum, revision will be part of the plan.

Twenty-one students made one of three types of comments regarding the grading being harsher than they expected. Some students used words or phrases such as *grade* or *grading* and *harsher* or more leniency being needed, although student 1 in fall 2012 MEEM 3220 used different phrasing alluding to the same issue. That comment included the sentence, "… I don't see the need to have everything so technically worded since this is our first time doing this stuff." It is not clear if the student is referring to the first exposure to the concepts in the course (students were required to take Introduction to Thermodynamics prior to enrolling Energy Lab) or the first time writing lab reports (as noted earlier, students first write lab reports in Integrated Design and Manufacturing Lab), or some other issue.

<u>Require GTAs to Follow the Guidelines/Rubric and/or Explain Their Interpretation</u>–Responses categorized in this theme fell into one of three subthemes. Some students indicated that there seemed to be a discrepancy in terms of the ways in which GTAs interpreted the guidelines and rubric. One student on fall 2012 stated, "I was happy with the rubric. The guidelines by themselves were not bad either. If followed they would lead to a well-written lab report. I hope that in the future the TA's will look at the guidelines more when they are grading the reports. This would allow students to receive more points than they have been getting, especially in the beginning

parts of the semester." This comment is of interest for a couple of reasons. First, this was the first semester the GTAs used the guidelines and also the first semester of training, thus some of the GTAs were not sure how or whether to use the guidelines, so they simply followed the rubric. While the two documents were supposed to be mapped to each other, as we will see in the next subtheme, there was room for improvement. Second, as noted earlier, one long-standing view held by faculty was that GTA grading prior to the training program commencing was too lenient, with GTAs focused too much on equations and graphs and not enough on written content. Thus, it was stressed in the training that the GTAs needed to follow the guidelines and rubrics closely and provide detailed feedback on the first few lab reports to "get the attention" of the students. Some students expressed a feeling that the grading, therefore, was too harsh, as will be discussed in a later theme.

<u>Improve Consistency Between Guidelines and Rubric or Lab Manual</u>–A small number of students expressed concern that the guidelines and rubric did not match in every section. The GTAs brought this issue to the attention of the teaching team throughout that first semester and several changes were implemented subsequently to bring the two tools more in line with each other, which likely reduced the number of students citing inconsistency between the documents as an issue.

<u>Inconsistency Between GTAs</u>–Again, students in MEEM 3000 raised concerns about consistency between GTAs, with forty-one students indicating they believed there was a problem. Student 81 in the fall 2012 class said, "get all the TAs all on the same page. I hate hearing that some class gets [to work in] groups on some assignments and others don't." Student 82 in the same course stated, "Make sure all the TA's have

consistent grading policies in a way that not just a certain lab group is getting way better grades than another and find TA's that can help and understand our questions." This comment is interesting in that the student seems to be differentiating between the role of GTAs and faculty by assuming that while each faculty member is likely (and even expected) to teach and evaluate a class in a different manner than another faculty member teaching the same class, this expectation does not hold for GTAs. This could be because students see the different sections of a lab course as still being *one* class or because they view GTAs much differently than they view faculty. This is an area that deserves more study.

<u>No Improvement Needed</u>–The final theme in question 6 was that no improvement was needed in the guidelines or rubric. Two hundred and seventy-two students either specifically stated that no improvement was needed or that both the guidelines and rubric were adequate, fair, or some similar language. Most of those students responding this way were in MEEM 3220, possibly indicating again the issue with evaluation consistency in MEEM 3000. Although no question explicitly asked about fairness, the word "fair" showed up in many responses to each question, indicating that students look for a sense of fairness in evaluation, but how this is defined needs more research.

Responses Related to the GTAs' Feedback: More is always desired

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 understand that writing is an iterative process, even in a lab course where there are no "drafts" and they appreciate when GTAs take the time to provide detailed feedback to help them improve future reports.

Question 5 responses: Responses to this question regarding whether the GTA's feedback was helpful fell into three major categories: 1) Feedback was helpful, when it was provided; 2) No feedback was provided or the feedback was too vague, came too late, or could not be found; and 3) Amount and quality of feedback varied between GTAs.

<u>Feedback Was Helpful</u>–A majority of students found their GTAs' feedback helpful in understanding the expectations of the lab report genre and technical writing in general. Detail was important, especially with that first report, as Student 75 in the spring 2014 MEEM 3220 course stated, "Absolutely. M---[19] tore our first few reports apart; really showing us what we could improve upon, and what was good with it." There were, however, a few students who admitted to not looking at the feedback, a concern expressed by some GTAs, as noted in Chapter 3. Student 73 in the fall 2013 MEEM 3220 course said, "I never really reviewed my submitted lab reports after the first one. I looked at the first one to see how the GTA wanted lab reports structured." I have no way of knowing the scores this student received so it may be that s/he was satisfied and did not feel the need to improve further. See Figures 16 and 17 for the response breakdowns to question five for each course.

<u>The More Feedback, the Better</u>–Most students who cited a problem with the feedback said it was lacking or nonexistent, too vague, or came too late to be of any help. The last issue tended to be a problem for GTAs who were either under pressure from

[19] Name deleted for privacy.

their advisors to complete a research project or were new to graduate school and struggling to juggle all of the demands on their time. Student 93 in the fall 2013 MEEM 3220 course noted a problem not only with a dearth of feedback, but also a lack of

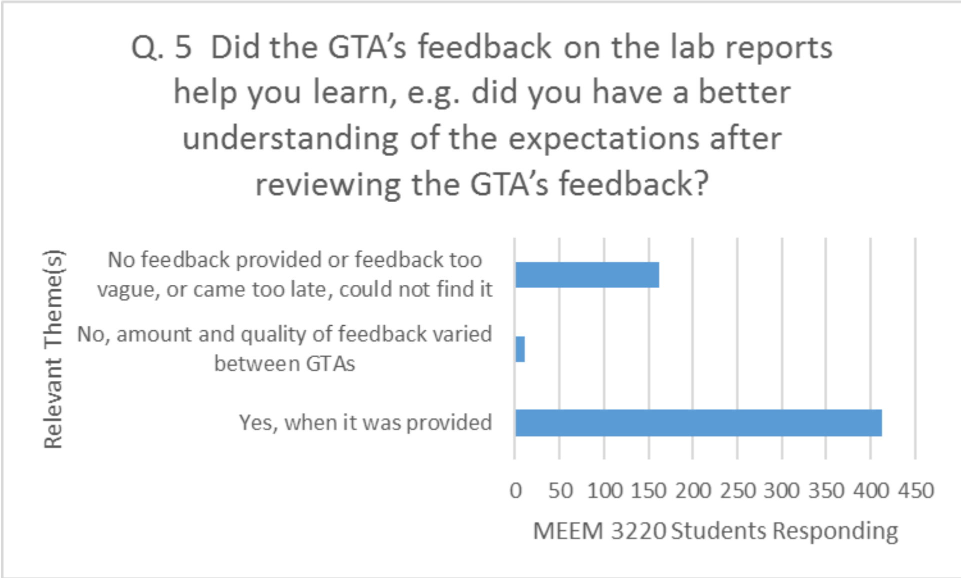

Figure 16 Question 5 responses from MEEM 3220

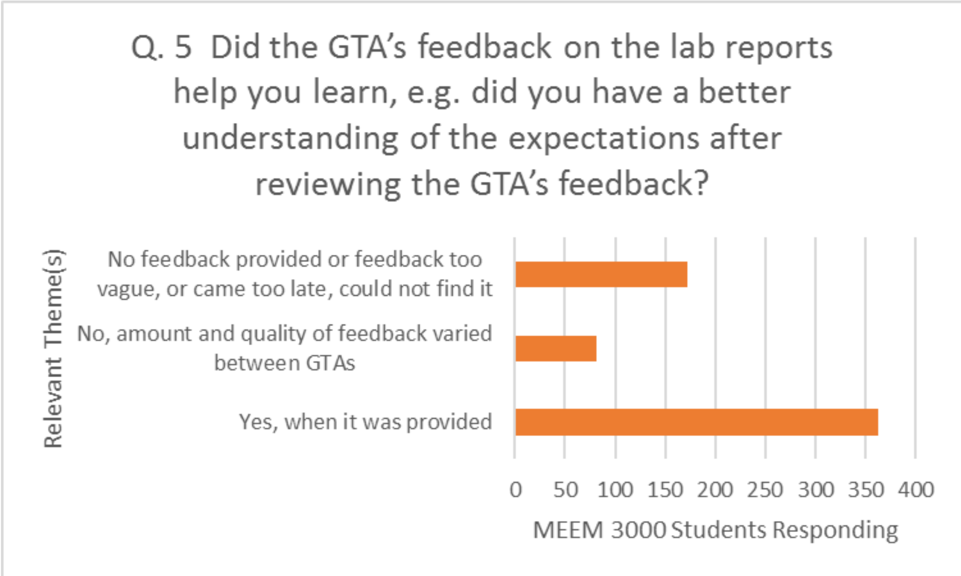

Figure 17 Question 5 responses from MEEM 3000

knowledge on the part of the GTA. Although lengthy, I include the full text here to accurately portray the student's concern and to show just how detailed some of the responses were:

> "No. The TA rarely gave feedback explaining why points were taken off. Especially in the group reports, I never once received feedback. Not that I would have taken it seriously because our TA's lack of knowledge or understanding of the lab principles discouraged me from taking anything useful from him. I can understand the inability to pronounce key words such as manometer, humidity, etc., but having to call another TA into our lab to explain how to actually do the lab is unacceptable. Sure it 'challenged' us to investigate how to perform the lab on our own, but his guidance was frequently wrong or detrimental to my understanding. I did have the opportunity to move to another TA's section for one of the labs and I was amazed at his (M---) knowledge and ability to explain the information to us. He very clearly understood the lab and its purpose and therefore gave us the chance to experience the lab as it was designed (we didn't have to explain to him what the lab manual said...)."

Students also cited trouble finding the feedback, an issue that arose most often when the GTA used the Crocodoc[20] function in Canvas. While this feature can be a timesaver for the evaluator and eliminates the need for paper printouts, for students to see the feedback, they have to adjust some settings in their Canvas accounts. Once the

---

[20] Canvas, the university's digital Learning Management System, includes a function called SpeedGrader that allows the instructor to add a rubric for each assignment. Within SpeedGrader is a function called Crocodoc, which allows the grader to provide feedback directly on the document submitted by the student.

teaching team became aware of this problem, we worked with the GTAs to make sure they explained their mode of feedback to the students and walked them through how to find the feedback.

Inconsistencies Between GTAs–Additionally, the issues of variance in quality of feedback differed between the two courses because students were able to make more direct comparisons between GTAs in MEEM 3000. Student 91 in the fall 2014 course stated, “Generally, yes. U--- and M--- were very helpful with their comments. They said exactly what was wrong and how they expected the information to be presented in the next report. However, Y--- generally left vague comments (one I received literally said ‘vague’ and nothing else). …” As with the guidelines and rubric, the students had plenty of suggestions for improving the feedback in future courses, which are presented in the next section.

Question 7 responses: Responses fell into five main categories: 1) more detail needed, 2) make feedback easier to find, 3) more timely feedback, 4) more lenient grading/allow for resubmission, and 5) no improvement needed. See Figures 18 and 19 for breakdowns for each course.

More Detailed Feedback–Students made four suggestions to improve the quality of feedback–provide feedback in the first place, not just scores; comment on what is done well; indicate how a section could be improved; and provide more feedback on local issues (just a few students suggested this last item). Many students specifically stated something about improvement needed in the quantity of feedback, with some students indicating their GTAs gave no feedback, saying, “Give feedback would be a pretty good start” and “Get TA’s that actually leave feedback.” The number of students asking for more feedback in general declined each semester in both courses, indicating that the teaching team and the training were successful in getting the message across to GTAs that the students relied on detailed comments to improve their technical writing.

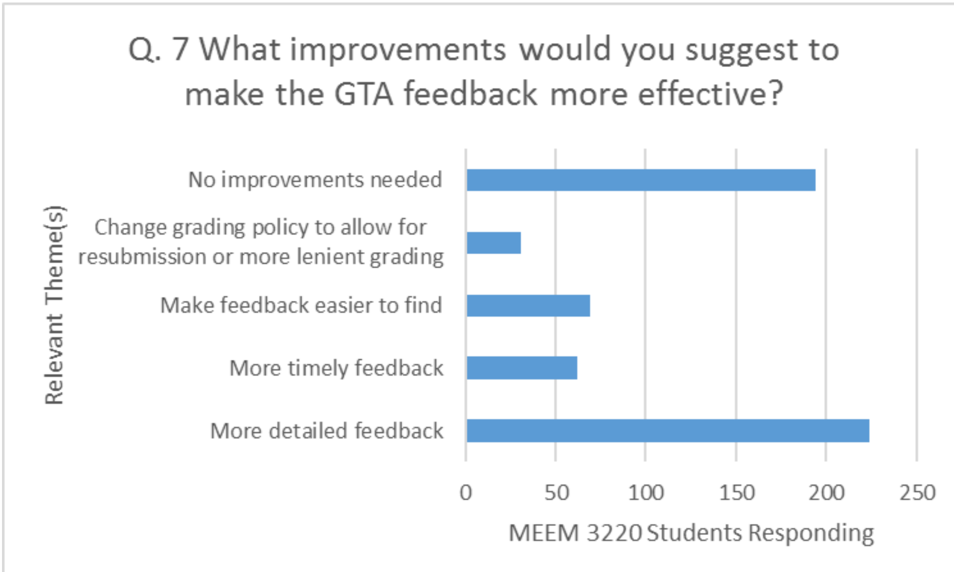

Figure 18 Question 7 responses from MEEM 3220

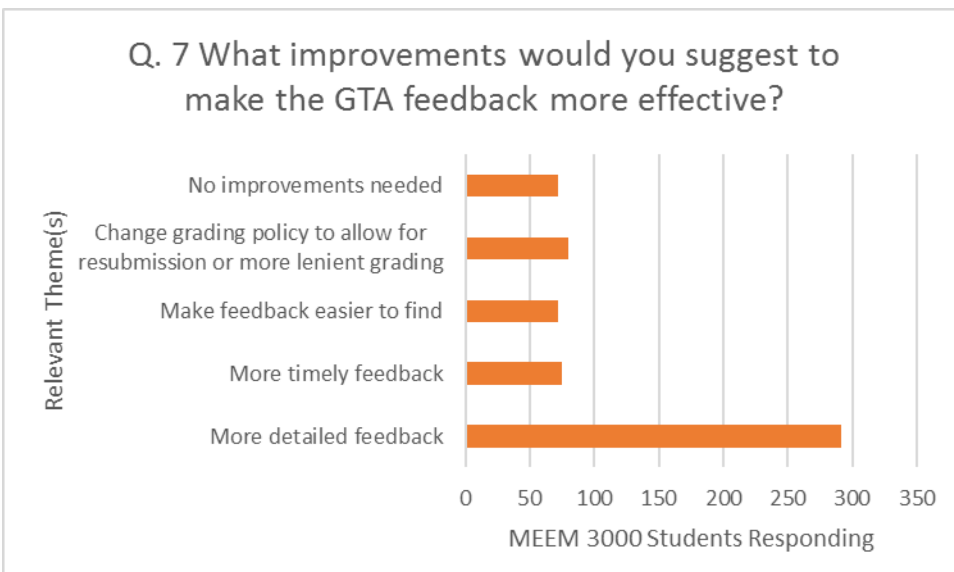

Figure 19 Question 7 responses from MEEM 3000

The second subtheme focused on commenting on things done well. Seventeen students indicated they would like feedback that pointed out what had been done correctly as a model for the future. The GTAs were instructed during their training to use the student's own work done correctly as a model the student can follow in the future by pointing out what was written effectively. Since just a few students cited this as an issue, it is likely most of the GTAs were doing this when they evaluated reports. In a related and much more common subtheme, 257 students asked that GTAs show how to fix mistakes as opposed to simply deducting points for errors. The GTAs are encouraged to provide this type of feedback at the beginning of the next lab session after returning the reports, especially for common errors. It was not clear from the responses if this was done and the students preferred to receive such feedback in the form of written comments on their reports or if this step was missed completely.

Location of Feedback–The second theme emerging from this question showed that some students preferred feedback written on printed copies of the reports, in comments on the Word document, delivered in class, or in some other format. For the first time ever students were required to submit their reports online via Canvas and some GTAs chose to post their comments within Canvas while other GTAs printed the reports and returned them to the students with comments. Several students requested feedback on hard copies of the reports, although this suggestion was made less often as students and GTAs became more familiar with Canvas. Just one student specifically stated putting comments in the Microsoft Word version was *not* helpful, while two other students stated the opposite. A few students suggested the GTA should discuss common errors in class, which I encouraged as part of the training.

More timely feedback–A sizable number of students in each course suggested GTAs make an effort to provide feedback on their reports sooner. Taking note of their placement in the surveys, responses from these students were usually grouped into the same sections, meaning a particular GTA was the problem, not the evaluation system. As noted in Chapter Three, those GTAs who were also research-active PhD students often struggled to manage their research and teaching responsibilities, leading them to sometimes fall behind on grading. This problem has occurred each semester as the department struggles to find a balance between the demands of the GTAs' advisors and the needs of the students and course instructors.

Grading Issues–This question did not address grading, but about 100 students expressed concerns related more to scoring than feedback. Most of the concerns were related to ensuring the GTAs' grading was consistent with the guidelines, rubric, and lab manuals, which has already been addressed. Ten students suggested allowing resubmission of reports to earn back points or submitting a draft of the first report. Student 34 from the spring 2013 MEEM 3000 course said, "For the first lab, I think TA's should recommend that students submit a rough draft before the lab is due so they can get an early idea of the expectations of the course rather than find out after they have turned it in." Unfortunately, due to the volume of reports (about one every week) and number of students (forty to forty-five per GTA), we were never able to fit multiple submission opportunities into the schedule.

Additionally, several students made reference to GTA performance issues unrelated to feedback on the lab reports. The wording varied with this label, but only those comments related to performance and not related to feedback on the reports were included. Thirty-one students, the majority of them in MEEM 3220, said their GTA needed to prepare more for the actual lab because the person was not able to provide adequate guidance and answer questions during the lab. Student 84 in the fall 2012 MEEM 3220 course stated the concern most clearly and in some depth:

> "I heard from a TA from a whole different lab that he has seen a TA be a student in a class for a semester before they teach it so they understand what the students have to do for each report and how to conduct each lab. This would allow them to have a better understanding of what the lab is about, including how to calculate the needed values and run the equipment, and what will be done in the lab report. I don't know what training they go through now, but maybe more training on how the equipment works and how to use equations because I was getting lost in my GTA's explanation for some of the labs later on in the semester."

Many GTAs, especially those who took their undergraduate degree in China, also shared the concern that they were not well prepared to lead lab courses because their own curriculum was more theory-based, with little hands-on experience. The teaching team discussed this issue and implemented more lab training for the GTAs, however, the number of students indicating this was an issue continued to fluctuate. This response was more common in fall semesters, though, when the GTAs were more likely to be new to the course. It makes sense that the more experience one has with a particular subject, the better one will be able to teach that subject.

Also in this subtheme, a few students wanted the GTA to more fully explain each lab experiment, a concern also addressed by the teaching team. Twenty-nine additional students indicated their GTA did not "take the job seriously" or should "take more time to grade (the lab reports) to do a more thorough (sic, wording missing). It seems like maybe he rushed through them to get them done." Finally, just a few students made reference to their GTA's problems with articulating in English, which the teaching team saw as a positive indication that language was generally not an issue with the GTAs. It is important to note that GTA positions are awarded to ESL students only with high GRA verbal scores.

No Improvement Needed–Nearly half of the students in MEEM 3220 indicated they either had no suggestions for improving the feedback or that no improvement was needed. Conversely, less than a quarter of MEEM 3000 students responded this way. In addition to the aforementioned issue with the structure of the course, these students also had more experience with the curriculum and teaching conventions in general, being in their fourth year of study, and therefore might have been more inclined to provide feedback of their own. In reviewing the responses across classes and semesters, I noticed that the MEEM 3000 students were more inclined to write more detailed explanations, using specific examples, while the MEEM 3220 students were more likely to write one or two-word, often vague, responses.

Conclusions and where we go from here

This survey proved to be the most valuable assessment tool for the training program and provided a much-needed view into the mindset of our students when it came to these lab courses, which the teaching team knew would be changing with the new curriculum. At the end of each semester, I reviewed the survey responses to determine if previously mentioned concerns had been resolved and if new issues emerged. Students' satisfaction with the guidelines increased over time as the teaching team continued “tweaking” these until midway through the fall 2013 semester. Concerns about the rubric remained stable after the spring 2013 revision in MEEM 3220. The number of students indicating a need for more feedback also decreased over time. Interestingly, requests for more specific feedback increased. This could be because students developed a better understanding of what they needed to improve in the future and the GTAs became more adept at providing feedback in general.

By studying the students’ responses for recurring themes, I was also able to adjust content and emphasis of certain aspects of the training to improve effectiveness. An example is the use of Canvas. Once I understood the students’ and GTAs’ concerns, I was able to educate the GTAs on the importance of explicitly explaining their preferred mode of feedback to students. Faculty also made more of an effort to better prepare the GTAs for each lab once they saw the pointed comments from students. As a result of this additional focus, concerns about the GTAs’ preparedness declined in later semesters.

Relevance to the new curriculum

The three lab courses in this study are being replaced with a new mechanical engineering practice curriculum designed to provide even more hands-on experience as well as much more variety in assignments, with use of traditional lab reports limited to just two or three per semester in the four-course sequence. For one thing, a new technical communications curriculum, along with a textbook for use in all four semesters, is being implemented in the ME Practice courses. The textbook, *Technical Communications: A Reader-Centered Approach* by Paul V. Allen, uses an Aristotelian rhetorical approach with its emphasis on the importance of audience and persuasion in technical communication and also includes lessons on inclusive communicative practices considering culture, diversity, and ethics.

The GTAs involved in the ME Practice courses, which started in fall 2014, are required to complete the same training program as the lab GTAs, but the more varied nature of the assignments does pose a few challenges. For one thing, there are no guidelines for evaluation nor have rubrics been adopted for all four courses, in part, because the assignments are so distinct, a positive step forward in terms of developing creative and critical thinking skills. Also, many of the faculty involved with the ME Practice curriculum do not support the use of rubrics because of the lack of flexibility in grading. With this flexibility, though, comes consistency issues, as we have already seen in the first few semesters of the new courses. I have worked to ensure that grade-norming sessions are held at least once during the semester for each course, and I continue to meet periodically with the GTAs from each course to hear their concerns and provide guidance.

In place of the survey, I have instituted an assignment at the end of each ME Practice course in which each student composes an essay reflecting on his/her learning in the course and progress through the degree program. Such reflection helps them make connections between course content and see how much they are developing as engineers as they move through program. I also ask students to discuss what worked for them and what did not in terms of course structure and teaching methods. This information has proven just as valuable as the surveys in helping improve the course content, GTA preparation, and student experiences. These essays are processed using thematic analysis, an endorsement of just how valuable an analysis tool I found it to be for understanding the varied perspectives of the students.

The next chapter explores the final component of assessing the efficacy of the training program–a blind review of student writing.

Chapter Five: Assessing Student Writing

The final aspect of program assessment involved a review of student written artefacts. I used final reports from the MEEM Senior Capstone Design program because these reports represent the pinnacle of the BSME program. This chapter provides an overview of the literature on writing assessment, followed by a discussion of the structure, results, and conclusions drawn from the assessment.

Evolution of Assessment

The history of assessment in the field of technical communication mirrors that of composition/writing assessment in general so this discussion will include scholarship from both disciplines. Russell (2002) describes how higher education in the U.S. gradually shifted along with the culture from an emphasis on oral communication to the written word and from a liberal traditional education focused on Latin, Greek, mathematics, and rhetoric to disciplinary majors (pp. 36-37). In the earlier curriculum, college students completed oral examinations, with some written essays, which were evaluated by university faculty committees. The shift to the German model of specialized disciplines brought a need for new methods of assessing whether incoming students were prepared for college and whether graduating students could effectively apply what they learned in their coursework, as determined by the disciplinary faculty and their professional societies (pp. 46-47). Almost as soon as universities adopted the German model of dissertations and similar written products, faculty complained about their students' so-called poor writing skills. Harvard University President Charles Eliot took the first step toward what we think of today as a writing program by hiring a journalist to teach composition in 1872 and instituting a grading scheme for writing. A year later, Harvard implemented a written entrance exam, evaluated solely on "grammatical and mechanical correctness" (p. 50). In subsequent decades, course and program theses grew in popularity, with more emphasis on content and context, although grammar and mechanical elements remained a primary concern of some faculty, a concern that continues even today.

Boyd (1998) further traces the evolution of grading scales in the U.S. and their emphasis on order, control, correctness, and eradication of error. Grades were developed to differentiate the top students from the average and underperforming students. Today, grades are an integral part of the entrenched hierarchy of academic culture. They determine whether students get into the college of their choice (colleges are ranked according to perceived quality of programs) and whether students obtain their dream job or get into graduate school. To achieve these marks of success, students know that grades matter so they seek, and even demand, high grades, perhaps at the expense of learning (Yancey and Huot, 1998). But what do grades mean in terms of assessment? How else are programs and students assessed?

Huot and O'Neill (2009) identify two distinct threads in the assessment methodology debate: "the role and reliability of holistic scoring of student writing" and "the development of validity as a psychometric concept" (p. 2). One of the first studies of writing assessment, conducted by Starch and Elliott in 1912, revealed a problem with reliability when a group of teachers could not agree on what grade to assign to the same essay. Decades later, in the midst of World War II, expediency and economy took precedence as the new multiple choice Scholastic Aptitude Test (SAT) replaced the essay-based College Entrance Examination Board to allow faster admission for students who had deferred military service for college. Although English teachers decried the use of such tests, which they believed lacked validity and proven reliability, the tests were easier to administer and much simpler to evaluate. Essay testing was reinstated sometime after the war, but the problem of reliability remained. Diedrich, French, and Carlton reported on a study of fifty-three evaluators who each assessed 300 papers, with 94 percent of the papers receiving at least seven different scores (out of a possible nine) (Huot and O'Neill, 2009, p. 3). The researchers were able to discern five distinct categories on which the evaluators were basing their scores: ideas, form, flavor (style), mechanics, and wording. These factors grew into an analytic scoring system where different categories could be weighted depending on the goals of the assessment.

A different style of scoring that evolved into holistic scoring was reported in 1966 by Godshalk, Swineford, and Coffman, who worked with the ETS (Educational Testing Service). ETS developed standardized tests such as the TOEFL (Test of English as a Foreign Language) and GRE (Graduate Record Examination) (Huot and O'Neill, 2009, p. 3). In the holistic scoring methods, evaluators used a rubric and underwent training in using the rubric to assign a single score to a paper, as opposed to multiple scores for different aspects such as grammar or structure.

We see both the analytic and holistic methods still in use today. Currently, the focus is on assessing certain core competencies established by individual programs, universities, and national entities such as Writing Program Administrators (WPA), the National Council of Teachers of English (NCTE), and ABET (formerly known as the Accreditation Board for Engineering and Technology). For example, the WPA calls for internal self-study as does ABET. While some entities like ABET provide core competencies (the notorious a-k program outcomes), others like WPA encourage institutions to develop their own competencies based on the unique goals and objectives of each program. For example, Coppola and Elliott (2007) describe the use of portfolios to assess whether students completing a technical communication course at New Jersey Institute of Technology meet eight core competencies in writing and editing, document design, rhetoric, problem solving, collaboration, interpersonal communication, specialized expertise, and technology. These competencies were established by disciplinary faculty involved with the Master of Science program in technical communication. In contrast, Johnson (2006) describes the use of ABET criteria in assessing electronic portfolios at the undergraduate level at the same institution.

Assessment methods, technology, and philosophies evolve with trends in education, societal needs, and political movements. Next, I will explore a few key debates in the field of composition and technical communication.

Key Debates

Three debates in the field of writing assessment are important to my research: reliability versus validity, formative versus summative assessment, and the level of knowledge that students transfer from first-year composition to disciplinary writing tasks. Although I use the adversarial term "versus," my objective here is not to argue for one approach over another or to place one trait over another. Rather, I want to consider what each method or trait can bring to the assessment process based on the goals of the assessment.

Reliability and Validity

The first issue of importance for my research is whether my method of writing assessment is reliable and valid. Cherry and Meyer (2009) define reliability as "how consistently a test measures whatever it measures" and validity as "whether the test measures what it is designed to measure" (p. 30). The literature tends to describe these traits as being in tension with one another, with some methods seen as more reliable <u>or</u> valid than another, as though one must be sacrificed for the sake of the other. However, while a method can be reliable without being valid, a method that is not reliable can never be valid.

The issue of reliability is easier to address than validity through use of devices such as rubrics. Reliability in writing assessment is concerned with consistency between raters evaluating the same artefact. To understand reliability, we must consider three aspects–measurement error, analysis of variance, and the contextual nature of reliability (Cherry and Meyer, 2009, p. 30). Determining measurement error requires some knowledge of statistics and a bit of educated guessing. Since no single person will perform a task the same way twice, statisticians use an observed score, which is a person's true score (reflecting perfect, complete knowledge and a perfectly devised test) plus a degree of error. To find error, psychometricians use analysis of variance to find sources of error. In educational assessment, Sax found three main sources of error (1974, p. 196):

1. Characteristics of students–no student will produce the exact same writing sample on different occasions because of timing (morning, afternoon, or evening), recent experience, physical conditions, etc.

2. Characteristics of the test–different essay prompts will elicit different responses from a given student's point of view and life experience.
3. Conditions affecting test administration such as rater training and personal values. Even with rubrics, it is impossible to eliminate all variance between individual raters.

Thus, for any method of writing assessment to be reliable, it must take into account the nature of the students being assessed, the design of the assessment tool, and the nature and context of the assessment event, which includes the scoring. For example, if one wanted to assess the writing skills of an economically, racially, and linguistically diverse population of incoming first-year students, it would be wise to provide a diverse choice of essay prompts and include an equally diverse group of raters trained to value a range of perspectives.

Turning to validity, Moskal and Leydons (2000) identify three types of evidence to consider in assessment validity–content, construct, and criterion. Content-related evidence includes:

1. Whether a student's response to a particular assessment accurately reflects her knowledge.
2. Whether the assessment tool accurately reflects the content domain (in the case of my research, do the lab reports accurately reflect student knowledge of the lab content or her ability to follow direction for procedure or formatting, or both).
3. Whether the scoring rubric accurately reflects both of the above-mentioned types of evidence.

Construct-related evidence involves ability internal to an individual such as reasoning or imagining. While the act of reasoning or imagining happens in a person's mind, the result of such an act can be demonstrated through some methods of assessment more effectively than others. For example, one could reason incorrectly and still mark the correct answer on a multiple choice test. Such tests are also poor measures of a person's level of imagination or creativity. While we might be able to assess a student's knowledge of local issues in writing (grammar, punctuation, and sentence structure) via a multiple choice test, that would tell us nothing about a student's ability to craft an argument.

Finally, criterion-related evidence concerns how well an assessment predicts future performance or can be generalized to other activities. For example, will a student who earns an A grade on her portfolio in Composition perform equally as well on writing tasks in her chosen discipline? For the scoring rubric to yield such a prediction, it must reflect the general characteristics of value in that transfer (a discussion of transfer will follow shortly). One example is the University Student Learning Goal rubric for written communication that was "designed to align with the university's strategic plan, professional accreditation outcomes (ABET, AACSB, SAF), and American Association of Colleges and Universities (AAC&U) LEAP Essential Learning Outcomes" (MTU website). The First-Year Composition[21] program has stated its objective as having the majority of student at least at Level 2 Developing by the end of the course, which should mean students are ready for disciplinary writing tasks.

[21] All bachelor's degree-seeking students are required to take this course or have earned credit through advanced placement courses in high school.

So where does the debate over reliability versus validity come into the discussion of assessment? While evidence seems to indicate rubrics improve reliability, the writing community is not in agreement with their use. White (2007) advocates the use of well-designed scoring guides, or rubrics, to improve assignment clarity and aid in grading (p. 75). Andrade (2001) argues that rubrics have several features that support student learning (and, conversely, help GTAs new to evaluating writing perform more effectively):

- they are written in a language that students understand;
- they define and describe quality work;
- they refer to common weaknesses in student work and indicate how such weaknesses can be avoided; and
- they can be used by students to assess their works-in-progress and thereby guide revision and improvement

She notes that most rubrics include a detailed list of criteria for the assignment and performance descriptions for each criterion. In the case of the lab reports at the center of my research, the rubric includes each section of the report and descriptions of what constitutes an "excellent" section, "good," and so on.

Rubrics have detractors, though, because they limit evaluators from interpreting a work beyond the parameters of the rubric, leading to problems of exclusion of diverse writing styles (Wilson, 2006; Broad, 2003). There is also the issue of power at play in rubrics (White, 1996). Who is developing the rubric and by what standards? Rubrics are one way a specific discourse is reinforced and bounded by those in power, thereby limiting access to the discourse by "outsiders" (Foucault, 1971). As I will note later in this dissertation, the issue of expediency is also central to the use of rubrics and something of which to be mindful.

Formative versus summative (outcome-based)

The next debate is over the use of formative versus summative, or outcome-based assessment. Recall that 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 (Yorke, 2003, pp. 478-479). 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). While formative assessment involves a dialogue with the student, summative assessment is the “final word” on a student’s work and is concerned with evaluating an artefact to determine if a student has met particular course or program goals (Yorke, p. 479). Accreditation boards such as ABET are focused on the latter and establish sets of requirements (ABET’s ubiquitous a-k student outcomes). Assessments can be both formative and summative in the case of an exam in which the student can learn from feedback and a grade is recorded that supposedly reflects the level of knowledge demonstrated by the student.

While students, especially those for whom English is not their first language, are weary of assessment, they like to have their work validated so they seek assessment that indicates if they are learning what they need to succeed in future applications. In general, White (2007) argues that students want assessment that does the following (p. 22):

- Stresses the social and situational context of the writer.

- Is designed to provide immediate feedback to the student.
- Breaks down the complexity of writing into focused units that can be learned in sequence and mastered by study.
- Produces data principally for the use of learners and teachers (rather than bureaucrats).
- Focuses on critical thinking and places surface features of dialect and usage in a large social context.

Yorke also argues that research shows students respond positively to formative assessment (they appreciate and expect feedback). Whether they actually learn from that feedback depends on its timeliness (do they receive it in time to reflect on it and apply it) and its relevance (does the student see the value of reflecting upon and incorporating it into future work or does she just look at the grade and move on). We must also consider what is fair and effective in assessing the writing of ESL students. Assessment of communication skills of ESL students, the number of which fluctuates in the BSME program, continues to vex faculty charged with such assessment because of lack of skill on the part of the assessors and cultural disconnection on the part of those being assessed (Matsuda and Silva, 2006).

Hamps-Lyons echoes this sentiment when discussing assessment of immigrant students, stating that, "most composition teachers have no training teaching second-language writing; most of them learn to be sensitive to their second-language writers through trial and error, which is not the best way when the errors are mistakes made in individual students' lives (p. 227)." While faculty have been shown to be less critical of ESL writing, such laxity can lead to miscommunication between the student and reader.

A variation of this issue is a common occurrence in ME-EM lab classes with ESL graduate teaching assistants who do not feel comfortable with their own English skills and, therefore, do not spend time providing effective feedback on lab reports, the first technical writing experience for ME-EM students. This lack of attention catches up with all the students, but especially ESL students, once they reach Senior Design and are held accountable for poor writing according to standard American English. After all, if one's incorrect work is never corrected, how does one learn that it is incorrect in the first place?

However, it takes time to provide effective feedback, which is a major reason disciplinary faculty often shun written assignments–the time commitment (Halasz and Brincker, 2006). This time commitment conflicts with four pressures Yorke says are threatening the use of formative assessment in higher education (p. 483):

- An increasing concern with attainment standards, leading to great emphasis on the (summative) assessment of outcomes.
- Increasing student/faculty ratios, leading to a decrease in the attention given to individual students.
- Curricular structures changing in the direction of greater unitization resulting in more frequent assessments of outcomes and less opportunity for formative feedback.
- The demands placed on academic staff in addition to teaching, which include the need to be seen as 'research active,' the generation of funding, public services, and intra-institutional administration.

These pressures are leading universities, including Michigan Tech, to place a high value on summative assessment (witness the aforementioned University Student Learning

Goals) because the results of such assessment activities can be quantified and simplified for consumption by key constituents, i.e. prospective students, potential donors, legislators, and employers who hire our students. Eccelstone (1999) argues that outcomes-based assessment serves the student by demonstrating the value of her education as it relates to future prospects in the labor market, i.e. what you "learn" in this degree program will translate to a position as a _____ with a salary in the range of Y to Z. But this argument runs down a slippery slope of expediency. In his 1992 article "The Ethic of Expediency: Classical Rhetoric, Technology, and the Holocaust," Katz uses a Nazi-era memo explaining the need for vans to be modified to be more effective in the extermination process as means of highlighting the worst case scenario of what can happen when intelligence is devoid of virtue. Katz argues that, technically, Hitler's motives were ethical in the sense that he believed what he was advocating–the elimination of those he viewed as enemies of Aryan people such as Jews, Gypsies, and homosexuals–was in the best interests of Germany. The architects of the Holocaust used the most efficient, and arguably the most effective, methods to achieve this goal. Katz defines this emphasis on using the most efficient and effective means to achieve a particular end as the ethic of expediency. This ethic places the needs of the whole over and above the needs of the few, which, on the surface sounds logical. Katz, however, goes further to give specific late-20th century examples of how economic expediency was prioritized above human life, such as ignoring threats of terrorism in advance of the Pan Am Flight 103 bombing on 1988 because thorough aircraft and passenger checks would have inconvenienced flights.

If we agree with Katz's interpretation of Aristotle's statement that "utility is a good thing and that any end is a good," then giving students and employers what they want from a college education is good and ethical, right? The answer, if we want a truly educated population, is of course not. Brookfield (2005) argues that a college degree should involve more than obtaining a job after graduation. Rather, it should involve empowering students to critique the existing system so that it can meet their needs instead of meeting the needs of potential employers. Additionally, the question of whether skills students learn in coursework even transfer well to employability is related to the issue of transfer, the final debate I will discuss.

Transfer from composition to disciplinary writing

Wardle (2007) writes that while the concept of transfer is a hot topic of discussion within the field of composition, whether transfer even occurs is still contested (p. 65). Transfer can be defined based on several characteristics including conceptions of tasks to be performed (knowledge learned to complete task A can now be applied to task B), the individual's level of motivation to apply prior knowledge to new challenges, and contextual conceptions based on situation, sociocultural perspective, or organizational protocol (pp. 67-68). Another term used for transfer, generalization, incorporates both the task and sociocultural aspect of knowledge application. I prefer the phrase "make connections" as in whether students are able to make connections between what they learn in First Year Composition (FYC) about rhetorical concepts and the composing process and their course assignments in mechanical engineering.

Nowacek (2011) wrote a book about an entire degree program developed with the goal of facilitating transfer at a liberal arts college, but FYC does not have that kind of opportunity or flexibility and struggles to meet the needs of diverse disciplinary programs and student attitudes. Bergmann and Zepernick (2007) studied transfer at Missouri University of Science and Technology and found that a major barrier to transfer from FYC to disciplinary courses was students' attitudes towards English courses in general, including FYC. Three themes prevailed in the researchers' interviews with the students (p. 129):

- Students saw writing in FYC as "personal and expressive rather than academic and professional" and resisted instructor comments and suggestions as "intrusions" on their "personal and intellectual territory."
- Students saw writing in FYC as a matter of "personal preference and opinion, rather than informed judgment," governed by very few rules. In contrast, they viewed disciplinary writing tasks as highly regimented by standards, conventions, and rules.
- While students did see writing as a "portable" skill, they rarely cited FYC as a location of learning that skill. Instead, they saw other general education or disciplinary courses as providing that instruction.

Wardle (2007) found that many of her students failed to apply what they learned in FYC because subsequent courses did not demand the extended writing process or they did not see the value of putting in the extra time. She writes, "[S]tudents did not *perceive a need* to adopt or adapt most of the writing behaviors they used in FYC for other courses. As a result, some students tended not to use the strategies even when they knew they could have benefited from doing so" (p. 76). For students to effectively transfer and build on the skills they learn in FYC, faculty in advanced general education and disciplinary courses must draw explicit connections with the content taught in FYC and craft challenging assignments that force students to apply those skills. Another solution is to make summative assessment for accreditation more interdisciplinary. For example, when assessing Senior Capstone Design reports for ABET evaluation, rather than viewing the reports through the lens of mechanical engineering, view them through broader measures such as the University Student Learning Goals or by incorporating evaluators from disciplines other than engineering. Mansilla (2005) argues, "Whether students seek to develop a new technological product or to craft a more comprehensive explanation of cultural differences, the purpose of the work must serve as a guiding light to judge which disciplines ought to be included and how, and what points of integration and leverage might prove most productive" (p. 20).

Chosen Approaches to Assessment

The thread of interdisciplinarity is extended in this research through my approach to assessment. The GTA training program I developed is rooted in formative assessment theory–that students learn by receiving feedback on their work and then incorporating that feedback to improve performance in the future (Yorke, 2003). However, to determine if 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 in spring 2015 took 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 they required 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 course 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).

SCD is a four-credit, two-course sequence usually completed in the final two semesters of a student's BSME program. ABET requires all engineering students to have a significant design project experience late in their undergraduate studies. At Michigan Tech, this requirement can be fulfilled in one of two ways–by participating in SCD or as part of a four-semester Enterprise Program team project. Typical Enterprise experiences for BSME students involve the SAE competition teams, e.g. Clean Snowmobile Challenge, Baja, Formula Car, Supermileage, and EcoCar. The SCD experience centers on a design project developed with an industry customer, which provides a small budget, usually $4,000, to design a process or device and/or optimize an existing process or device necessary to that company's mission. About two-thirds of BSME students choose the SCD option, although a small number (about half a dozen out of 200+) participate in the International Senior Design Program coordinated by the Civil and Environmental Engineering Department.

The first semester of SCD encompasses the "paper" phase of the design process as students get to know their customer, develop an understanding of the problem, and brainstorm possible design solutions. The second semester is the "build and test" phase of the process. The final report, due during finals week of the second semester, is a cumulative document that teams begin composing in the first semester. They communicate their efforts by scaffolding upon the phases of the design process through a series of five reports total. They receive feedback from the program advisors and incorporate that feedback into the next version as they progress through their project work. The five reports each have templates with language explaining what should be included in each section. Neither the templates nor the course instructor changed between spring 2012 and spring 2015. The audience for these reports is their technical contact at their project company and engineers or technicians who might pick up the project several years in the future, which is quite common. Such an audience requires attention to detail and clarity so that someone who had never spoken with the team could replicate their work and pick up where they ended.

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[22], 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. Each student (referred to as "assessor" from this point forward) was paid $125 and provided lunch on the day of the assessment, which took place on June 2, 2015.

We began the day by reviewing the University Student Learning Goal Written Communication Rubric (MTU webisite) (Appendix F) and applying it to a sample SCD final report to establish a group understanding (norming) of the rubric's categories and evaluation criteria. Each assessor used the rubric to evaluate the relevant sections and then we came together as a group to discuss their interpretations. The rubric was originally developed by the American Association of Colleges and Universities as part of

[22] Four male, one female.; three from the United States (two white and one African American) and one each from India and China.

its Liberal Education Assessment Program[23] and was also vetted by a university committee of faculty with an interest in writing, so the wording was sufficiently clear. The norming exercise helped ensure the assessors were all interpreting the rubric in the same way to avoid inconsistencies. It should be noted that Report 1 in the 2015 group is the only one in which there was a deviation in rating of more than one point between the two raters. It is also the only report that scored Beginning 1 ratings out of both groups.

Eighteen final reports from each from the spring 2012 and spring 2015 semesters were selected and numbered (1-18 for the 2015 and 19-36 for 2012). Then, to make the assessment fit into a one-day period, I selected only the odd-numbered reports. Each assessor was then given a set of reports (four received seven reports and one assessor received eight) with all student identifying information removed. Each report was numbered and 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 is to have all students who complete the FYC course producing written work that is at least at the Developing stage. The provost's

[23] See the MTU website for detailed information about the University Learning Goals and the general education program.

office, which oversees learning goal assessment, 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. While the University Learning Goals were not in place at the beginning of the GTA training program, because the Written Communication rubric was vetted by a variety of faculty and is the main tool for writing assessment on campus, I chose to adopt it for this assessment.

Figure 20 on the next page shows the scores for each report from both assessors for each category. More reports from spring 2015 scored at the Proficient 3 or Exemplary 4 level in four of the five categories. I will discuss each of these categories and put the results into context for implications regarding the GTA training program.

Context and Purpose for Writing

For this category, the rubric states that assessors should look for the "[l]evel of understanding of context, audience (perceptions, expectations, assumptions), and purpose relevant to the writing tasks(s) and adjustment of writing address those considerations." Fifteen of eighteen ratings were at least a 3 for the 2012 group, while fourteen of eighteen ratings met that criteria in the 2015 group. With a difference of just one point, it is safe to say there was no measurable change in this category. 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, as I noted in Chapter Two.

Senior Design Final Report Summative Assessment Using University Learning Goal 5A Written Communication Rubric Spring 2012					
	Context and Purpose for Writing	Organizations and Conventions	Content Development	Sources and Evidence	Control Syntax and Mechanics
Report 19	3	3	2	2	3
	2	3	2	2	2
Report 21	4	4	4	3	3
	4	4	4	3	4
Report 23	3	3	2	2	3
	3	2	2	2	3
Report 25	3	3	3	2	3
	3	3	2	2	3
Report 27	3	2	2	2	3
	2	2	2	2	2
Report 29	3	2	2	2	2
	3	3	3	3	3
Report 31	3	3	3	3	3
	4	4	4	4	4
Report 33	4	3	3	2	3
	3	2	2	2	4
Report 35	3	3	2	2	3
	2	3	3	2	3

Spring 2015					
	Context and Purpose for Writing	Organizations and Conventions	Content Development	Sources and Evidence	Control Syntax and Mechanics
Report 1	1	1	1	2	2
	3	3	3	3	3
Report 3	2	3	2	2	3
	3	3	2	2	3
Report 5	4	4	4	4	4
	3	3	3	3	3
Report 7	4	4	4	3	4
	2	3	2	4	3
Report 9	4	3	3	3	3
	4	4	4	4	3
Report 11	3	3	3	2	3
	3	3	3	3	3
Report 13	3	4	3	3	3
	3	3	3	3	3
Report 15	2	3	3	3	3
	3	3	3	3	3
Report 17	3	3	3	2	3
	3	3	2	2	3

Figure 20 Summative assessment results

Organization and Conventions

Assessors rated reports in this category for “[c]lear and consistent organizational pattern and structuring elements including introduction, thesis and main points, conclusion, and transitions; follows formal and informal rules of genre or disciplinary expectations about organization, content, presentation, formatting, and stylistic choices.” While thirteen of eighteen ratings were three or above for the 2012 group, seventeen ratings met or exceeded that criterion in the 2015 group. While an increase of four is not a large number, it does demonstrate moderate improvement in students’ understanding of organizations and conventions in the engineering discipline. Recall that one of the goals of Writing in the Disciplines efforts is to bring students into the community of mechanical engineering by using writing assignments to teach its practices. This fact was emphasized to the GTAs and those GTAs who had industry experience excelled at such instruction in the labs.

Content Development

This was the first of two categories where students showed significant improvement. In this category, assessors were asked to rate how well the team “uses appropriate and relevant content to develop ideas, situate ideas in a disciplinary context, and shape the work.” While just eight of eighteen ratings met or exceeded the Proficient criteria in the 2012 group, thirteen ratings did so in the 2015 group. Recall that the lab report guidelines (Appendix B) were designed to help students understand that a report is a narrative, requiring each section to link to, and build upon, the previous section, thereby demonstrating a coherent thread for the reader to follow throughout the document. Such an emphasis on narrative in the lab courses may have contributed to students' improvement in this category in the SCD final reports

Sources and Evidence

The 2015 reports showed the most improvement in this category, in which assessors expected students to use "a variety of quality sources and acknowledge different views to support ideas appropriate for discipline and genre of writing (e.g. citation styles); may use data to support observations and draw conclusions." In the 2012 group, just six of eighteen ratings met or exceeded the Proficient criterion, while twelve of eighteen did so in the 2015 group. In the sections included for this assessment, sources are not typically cited (that comes earlier in the report's Background section). However, teams are required to provide supporting evidence for their claims. For example, they must explain why they chose to use a particular material in their design using engineering and economic principles, clearly describing any considerations made based on the project objectives and constraints. As with the previous category, I attribute the improvement here to the lab report guidelines, which stressed the importance of using data and one's engineering expertise to justify design decisions.

Control of Syntax and Mechanics

In this final category, fifteen of eighteen ratings met the Proficient criterion or exceeded it in the 2012 group, while seventeen of eighteen did so in the 2015 group. Assessors were looking for "quality of language use to communicate meaning and control over errors." I was not expecting any improvement in this category since I regularly emphasized to the GTAs to not focus on grammar and punctuation issues when evaluating the lab reports. There might, however, have been some tangential benefit to be had just by having students pay more attention to their writing in general.

Conclusions

While this assessment demonstrates some improvement in the quality of SCD final reports over a period of three year, 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 Senior Capstone Design (SCD) 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 are written by groups of two to three students and the SCD reports are written by groups of four to six students. In most cases, the best writer in the SCD group is responsible for compiling and editing the final report so what is really being assessed? Unfortunately, nearly all writing in the former BSME program 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. These skills are honed in the last ME Practice course through team assignments involving more complex thinking and organization, such as white papers and project proposals.

However, with the above caveat in mind, the cumulative evidence demonstrates the value of the GTA training program to the students, faculty, and GTAs themselves. In the next chapter, I follow Lauer and Asher's (1988) model that the final act of an empirical study like this assessment is to interpret and reflect (p. 6) and pull together the three assessment components to answer the two research questions posed in Chapter One and recommend ways this program could be adapted elsewhere.

Chapter 6: Concluding Thoughts and Implications

In this dissertation, I have described the structure, methods, and results of a program to train GTAs to more effectively evaluate student writing in required lab courses. Woven into this narrative are some insights into what I, and other ME-EM department faculty, learned during the course of this research and some ways we applied that knowledge to the development of a new undergraduate curriculum. In this chapter I will provide concluding summaries for the two research questions presented in Chapter One. I will also discuss some lessons learned during the course of this research, about the training program and some aspects of the instructional methods often adopted by large enrollment engineering programs. Finally, I will present some implications for WAC/WID program administrators and other educators interested in developing similar programs and/or using any of the research methods presented in this dissertation.

Research Questions Answered

Recall that I sought to answer two questions during the course of this dissertation research. First, using standpoint theory as a starting point to determine GTA needs, what effects do the tools (guidelines and rubrics) and training in formative assessment have on GTA performance, as measured by their own feedback during and after the training and feedback from students? Second, what effects do the tools and training of the GTAs have on the technical writing ability of the undergraduate students once they have completed all three lab courses? Once they reach Senior Capstone Design, do 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?

In the preceding chapters, I discussed the three components of assessing the training program including feedback from the GTAs themselves, survey responses from their students, and a formal assessment that compared Senior Design report sections from before the training was instituted to those crafted three years later. The evidence presented demonstrates that the program not only helps GTAs perform more effectively as evaluators of student writing, but also improves student writing to some extent. There are, however, some caveats to be made explicit before declaring the program a total success and also several implications for institutions interested in replicating this program.

Effects of Lab Report Guidelines/Rubric and Training on GTA Performance

Regardless of language background, GTAs are open, and often eager, to receive training in effectively evaluating student writing as well as other pedagogical methods. Furthermore, such training, when combined with faculty mentoring, does help GTAs be more effective instructors. Even when not anticipating a career in the professoriate, their statements to me show they recognize the importance of their role as GTAs and appreciate efforts to help succeed. They particularly value training that is directly applicable to the types of courses they teach, i.e. labs as opposed to lecture-style courses. Faculty mentoring does not have to be labor-intensive. Simply "checking in" with the GTAs once a week can help ensure they understand what is expected of them, in class and for evaluation, for the next week and to allow them time to ask questions and raise concerns. The faculty involved with the three labs included in this research found that just one to two hours a week is enough time to create a collaborative environment where faculty and GTAs can exchange ideas about improving instruction, lab procedures and the equipment used in the lab.

Similar to the experience that Anson et al describe in their 2012 article on assessment, one of the most valuable aspects of this research was that it was a catalyst for starting conversations about what faculty actually valued in teaching mechanical engineering. It is not an overstatement or hyperbole for me to argue that this project was transformative for me as an instructor/researcher and for the department in terms of how faculty view the role of GTAs in their classrooms. A person can read the literature and make hypotheses based on her own unique perspective/situation, but until theory is put into practice, one never knows whether the theory will need alteration. In my case, it was not theory that needed rethinking but stereotypes accepted as fact and practices seen as standard operating procedure. When I first broached the idea of training our lab GTAs to more effectively evaluate student reports, some faculty were skeptical, to put it mildly. They were doubtful of the GTAs' language ability since the majority spoke English as a second language. Once the relevant department faculty agreed to try such a training effort and began preparing the lab report guidelines and rubric that would guide the students and GTAs, we started asking deeper questions about the curriculum. These questions included why we were teaching particular topics, how we were using valuable lab time and space, and whether there were better alternatives that would help students learn more and retain that knowledge for future application. These discussions led to innovations in a new curriculum developed in parallel to this research. With any curricular discussion, though, comes the issue of class size since the ME-EM department's enrollment is growing at both the undergraduate and graduate levels even though the number of teaching faculty and support staff has not kept pace. Such a situation has led to large class sizes, reduced time for advising per student, and heavier workloads for GTAs who must balance their classroom duties with research responsibilities. Whether efforts put forth to train GTAs and continue innovating communication instruction at the current level are sustainable remains to be seen. Sustainability requires support beyond the department, which I will discuss shortly.

Effects of Lab Report Guidelines/Rubric and GTA Training on Student Writing

As noted in Chapter Five, I am more hesitant to declare that student writing has indeed improved based on just the one assessment conducted using the university's written communication learning goal rubric. Recall that in Chapter Two I raised the concern that I am not convinced that lab reports are a particularly effective way to introduce students to, and instruct them in, the conventions of the mechanical engineering discourse community. They are, however, expedient assignments that walk students through the lab experiment and provide an opportunity to practice formatting and using scientific language. That expediency raises some red flags for me as an educator

Expediency and sustainability: Expediency, at its best, can help faculty effectively teach large enrollment courses. At its worst, though, it can alienate students and/or leave them with critical gaps in their knowledge because of institutionally imposed resources constraints. In large enrollment programs such as ours, there is a pattern of lumping students together in groups for the sake of economies of scale, which can make it difficult to develop assignments and provide instruction to effectively teach communications and critical thinking skills. Current examples include engineering courses such as the ME

Practice four-course sequence that have between 80 and 265 students or Senior Design, which has a significant communications component, with 120 or more students. Such large class sizes necessitate the use of assessment methods that privilege standard American English and methods of instruction that take less time away to manage. One example is lectures, which allow little room for cross-cultural communication, the development of in-class relationships and understanding, or expression of knowledge learned in any manner other than a formulaic exam with one right answer but multiple wrong answers. The university saves money with large, highly-structured classes by hiring fewer faculty and using fewer facilities when the class size is large. Students pay the same tuition rate and receive the same MTU engineering degree, which is valued by employers[24], whether the class size is 25 or 200. The university enters into this arrangement knowing that students, particularly underprepared students with special needs for more contact with faculty and advisors, are short-changed in such a system if the goal is to teach students *how* to think rather than *what* to think (Duderstadt, 2008). To be fair, though, MTU also has a first to second-year retention rate of 87 percent (Fast Facts, accessed January 21, 2016) compared to the national average of 78.6 percent for doctoral-degree-granting public universities, according to ACT.org (College retention rates, accessed January 21, 2016).

Further Implications for WPAs and GTA Development Efforts

I have emphasized throughout this dissertation that this program is truly interdisciplinary because it draws from so many fields and that WID itself is the ultimate

[24] Michigan Technological University's Career Services website boasts, "Our placement rate for undergraduates is 96% (employed within their field of study, enlisted in the military, or enrolled in graduate school within six months of graduation). http://www.mtu.edu/admissions/outcomes/careers/

interdisciplinary project. The beauty of WID is that it can, and should, draw on diverse disciplines to prepare students for the challenges of solving multidisciplinary problems they will face as engineers (Duderstadt, 2008). However, for such an interdisciplinary effort to be sustainable, it must receive recognition and support beyond the home department. Without a university-wide communication program (or even one centered in a college of engineering), the commitment to including communication in disciplinary courses is vulnerable to the extent that, should I leave this position, the entire ME-EM Technical Communication Program (TCP) could evaporate. The position is currently funded with "soft money" via the department's corporate-funded Senior Capstone Design program and serves at the pleasure of the department chair. A change in leadership or economic downtown puts the position at risk.[25] This training program, and the TCP in which it is situated, receives no financial support from the graduate school, the university Center for Teaching & Learning[26], or the College of Engineering. It is possible that, with the university-wide establishment of learning goals in written and oral communication and their assessment, support for this program will be forthcoming.

Implementing similar programs elsewhere

With the above cautionary note in mind, this program can be replicated in any size undergraduate engineering program that uses disciplinary GTAs to assist with lab or other required courses. In fact, I did not restrict the training to GTAs teaching labs; instead I gave other faculty who used GTAs and had some sort of writing component in their classes the opportunity to have GTAs attend the training. From the beginning, all of

[25] Of course, I realize this is the case with most academic positions in 2016.
[26] The Center for Teaching and Learning does deliver the GTA service course, ED 5100 College Teaching and provides workshops for faculty and GTAs.

the GTAs involved with the MEEM 3900 Engineering Design Processes course completed the training and contributed their unique perspectives toward improving the program. The EDP course, as it was known in the department, was a precursor to Senior Capstone Design and incorporated many of the same rhetorical concepts as students completed design reports and presentations.

WAC/WID program administrators might have a smoother path to implementing a similar training program for engineering GTAs if their existing programs already have the support of the engineering dean, department chairs, and faculty. Without their support and willingness to engage in conversations about what they value in the teaching of disciplinary communication skills, to participate in discussions with the GTAs, and to stress the importance of the work of GTAs, the program will have limited success. GTAs, like everyone, need to feel their work has value and their opinions matter. Additionally, undergraduate students must hear from their faculty that communication skills are important and cannot be learned in just one course, e.g. composition.

I limit this discussion to engineering because engineering programs at doctoral-degree-granting universities often have a high number of graduate students who speak English as a second language and this program was developed with the needs of that population most prominently addressed. Many of these students have little experience with lab-style courses and need some extra mentoring in leading such sessions. They also need some models of effective disciplinary writing from which to base their future evaluations. While not everyone agrees with the use of templates and rubrics for communication assignments, GTAs need some guidelines to help them know where to focus their attention. Such guidelines also remove the feeling that grammar, punctuation, and formatting take precedence over content development. Once they have the training and tools, though, most of these GTAs will prove to be as effective as their domestic counterparts.

A Few Words Regarding Research Methods

Standpoint Theory in Higher Education Research

Standpoint theory has not received much attention in recent years and that is unfortunate because it has the potential to revolutionize higher education by putting the student first. The increased focus on assessment of skills that meet employers' needs has the potential to turn an undergraduate degree into a series of courses in disciplinary practicalities. I do not want to diminish the value of developing professional skill sets. In fact, many employers I have spoken with tell me they value communication, teaming, and critical think skills as much as technical skills. However, I do believe that we as educators would be more effective if we took more time to consider the needs of the students sitting in our classrooms when developing curricula. Project-based learning is an outgrowth of such efforts, as is the "flipped" classroom in which lectures are presented online and class time is used for problem-solving, group work, and answering questions. Such innovations will not work for all students, and that is why it is important to offer a plethora of learning tools to help students of diverse backgrounds and abilities succeed.

Publications geared toward university faculty and administrators are full of articles written from their own perspectives, but rarely do we hear from the students themselves about what teaching methods work for them, how they would like to interact with faculty, what they see as barriers to learning. I am not advocating that students should "run the show." However, I chafe at the argument that, because we are "experts in our fields and have earned PhDs, we always know what is best for students who might be a generation or two younger than us and come from backgrounds very different from our own. By incorporating standpoint theory methods into our pedagogical toolbox, we could be more effective teachers.

Recommendations for Using Thematic Analysis

Thematic analysis proved to be a valuable tool in reviewing the survey responses in this research. I found it especially helpful for categorizing the response for large enrollment courses. There are, however, some things to keep in mind when applying this method to large data samples. The first is to be cautious of data overload. Once the analysis began, it quickly became apparent that thorough analysis would require a considerable amount of time. The most time-consuming aspect was reading each response and determining to which code or codes the response belonged. Related to this issue is that the researcher must be prepared to rework themes, combining and pulling out themes for the most effective analysis. I found that once a theme was established, it was often necessary to break that theme into sub-themes or to create a new theme if there was enough differentiation in responses to warrant it. This is why thematic analysis is an inductive process, as Boyatzis describes it, requiring some personal experience and "intuition" on the part of the researcher.

Finally, while being able to interpret and categorize the information is the key to success with this method, the researcher must take care to be faithful to the respondent and recognize that each of us has biases. Avoid trying to "read" the respondent's mind. If the person did not say something the way the researcher expected, one cannot try to make the data fit a particularly bias.

In the end, the best indicator of the value of thematic analysis is that I chose to use it again in reviewing the reflective essay assignment incorporated into each of the four ME Practice courses in the new curriculum. Once themes are established, the process of analyzing an essay comes down to a search for key words or phrases matching those themes. From the themes, the researcher can then detect patterns, especially if a study occurs over a period of time. At the end of each semester, I prepare a report for faculty, discussing these themes and, by reviewing these reports over time, I can see where changes have been effective and what still needs additional attention. This information is helping our department more effectively transition to the new curriculum without waiting for other assessment tools such as department concepts exams or the ABET accreditation process, which takes place every six years.

Where We Go From Here

As I matured as a researcher and teacher in technical communication, I grew skeptical of, and discontented with, the narrow view of communication held by most faculty in the ME-EM Department. This view was that simply teaching the conventions of technical writing would help the students communicate effectively as engineers. Teaching the writing conventions of a particular discipline is a key aspect of the rhetorical approach in WID, but it is also important for students to learn to question those conventions when appropriate. As I developed the technical communication component for the new ME Practice curriculum, I encouraged faculty to deviate from the traditional lab report and incorporate assignments that require students to think critically about their roles as engineers (Bean, 2011). I also now require students to reflect on their own learning and the ways they will apply what they have learned, a technique familiar to those who work in the field of metacognition. I would also like to incorporate an assignment or two in each ME Practice course in which they can reflect on and understand their own power, privilege, and biases (Harding, 1991), especially as issues of racial and ethnic diversity grow in prominence on the nation's college campuses. Writing forces student to reflect on what they have learned and applying their newly acquired vocabulary to a written record of their experience, because taking an exam on what have heard in lecture or read in a textbook is not enough to engage fully with the material. Merleau-Ponty (1989) notes, "Reflection even on a doctrine will be complete only if it succeeds in linking up with the doctrine's history and the extraneous explanations of it, and inputting back the causes and meaning of the doctrine in an existential structure" (p. xix).

Changing the Discourse about Student Writing and GTAs

I indicated in Chapter Two that despite Michigan Tech's previous illustrious history with WAC, my efforts to implement communication instruction into ME-EM department courses was really a grassroots approach. To borrow from the movie "Field of Dreams," if I built a program course by course, lesson by lesson, students would come to improve their disciplinary communication skills. I have noticed that faculty now do not hesitate to emphasize the importance of communication skills to their students and encourage them to take seriously the instruction they receive on abstract concepts like audience analysis and content development, along with practical elements such as word choice, slide design, and public speaking. When it came time to develop the new curriculum, there was never any question that communication instruction would be a significant component in several courses.

So why does the "grassroots approach"[27] seem to be working to change the discourse about writing in one engineering department so that faculty become open to new initiatives such as this program? Foucault might argue, "it is not a change of content (refutation of old errors, recovery of old truths), nor is it a change of theoretical form (renewal of paradigm, modification of systematic ensembles)" (1984, p. 54). Rather it is a matter of what is controlling the discourse and allowing for that discourse to evolve in a way that is acceptable to the existing order. In the case in question, it was the engineering faculty who came to realize that simply "fixing" the mechanical problems that Senior Capstone Design students exhibited in their writing would not address their concerns that not enough critical thinking was occurring in the process of creating design reports. Students were trying to apply a formula to their writing, which resulted in lifeless, rudimentary, and even convoluted prose. Once we began to have discussions about what constituted effective communication and faculty shared their experiences with student writing, conversations about student writing focused less on rules and stereotypes and on fully understanding the language of engineering and the perspectives of our GTAs. Thus, students could "write like engineers."

---

[27] Grassroots in the sense that the program was developed in-house as opposed to being imposed from outside the department.

Works Cited

ABET Criteria for Accrediting Engineering Programs. (2015, November). ABET Engineering Accreditation Commission.

Ambrose, Susan A., Bridges, Michael W., DiPietro, Michael, Lovett, Marsha C., and Norman, Marie K. (2010). *How Learning Works: Seven Research-based Principles for Smart Teaching*. San Francisco, CA: Jossey-Bass.

Andrade, Heather. (2001, April). The Effects of Instructional Rubrics on Learning to Write. *Current Issues in Education*, 4(4).

Anson, Chris M., and Forsberg, Lee. (1990). Moving Beyond the Academic Community Transitional Stages in Professional Writing. *Written communication*, 7(2), 200-231.

Anson, Chris M., Dannels, Deanna. P., Flash, Pamela, and Gaffney, Amy L. H. (2012). Big rubrics and weird genres: The futility of using generic assessment tools across diverse instructional contexts. *Journal of Writing Assessment*, 5(1).

Aristotle, O., and Kennedy, George A. (2006). *On Rhetoric: A Theory of Civic Discourse*. Oxford University Press.

Bahls, Patrick. (2012). *Student Writing in the Quantitative Disciplines: A Guide for College Faculty*. San Francisco, CA: Jossey-Bass.

Baillie, Caroline and Elliot P. Douglas. Confusion and Conventions: Qualitative Research in Engineering Education. *Journal of Engineering Education*. Vol. 103, No. 1. January 2014, pp. 1-7.

Bandura, Albert. (1977). Self-Efficacy: Toward a Unifying Theory of Behavioral Change. *Psychological Review*. 84(2), 191-215.

Bandura, Albert. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of social and clinical psychology*, 4(3), 359-373.

Bandura, Albert. (1997). *Self-Efficacy: The Exercise of Control*. New York: W.H. Freeman and Co.

Bandura, Albert. (1999). Social Cognitive Theory: An Agentic Perspective. *Asian Journal of Social Psychology*, 2, 21-41.

Bazerman, Charles. (2011). Standpoints: The disciplined interdisciplinarity of writing studies. *Research in the Teaching of English*, 8-21.

Bean, John. *Engaging Ideas: The Professor's Guide to Integrating Writing, Critical Thinking, and Active Learning in the Classroom*. San Francisco: John Wiley & Sons, 2011.

Bendassolli, Pedro F. (January 2013). Theory Building in Qualitative Research: Reconsidering the Problem of Induction. *Forum: Qualitative Social Research*, Vol. 14, No. 1.

Berger, Peter L. and Luckmann, Thomas. *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. Anchor Books, 1966.

Bergmann, Linda S., & Zepernick, Janet. (2007). Disciplinarity and transfer: Students' perceptions of learning to write. *WPA: Writing Program Administration*, 31(1-2), 124-149.

Berliner, David C. (1988). Implications of Studies of Expertise in Pedagogy for Teacher Education and Evaluation. *New Directions for Teacher Assessment*. Proceedings of the ETS Invitational Conference (49th, New York, NY, October 29, 1988).

Bosley, Deborah S. "Cross-Cultural Collaboration: Whose Culture Is It, Anyway?" *Technical Communication Quarterly*. 2:1 (1993): pp 51-62.

Boyatzis, Richard E. (1998). *Transforming Qualitative Information: Thematic Analysis and Code Development*. Thousand Oaks, Calif: Sage Publications.

Boyd, Richard. (1998). The Origins and Evolutions of Grading Student Writing. *The theory and practice of grading writing: Problems and possibilities.* Albany: State University of New York Press.

Braine, George. (Ed.). (1999). *Non-native Educators in English Language Teaching*. Mahwah, NJ: Lawrence Erlbaum.

Broad, Bob. (2003). *What We Really Value: Beyond Rubrics in Teaching and Assessing Writing*. Logan, Utah: Utah State University Press.

Brookfield, S. (2005). *The power of critical theory: Liberating adult learning and teaching. San* Francisco: Jossey-Bass.

Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done? *Qualitative research*, 6(1), 97-113.

Carter, Michael. (2007). Ways of knowing, doing, and writing in the disciplines. *College Composition and Communication*, 385-418.

Cherry, Roger D. and Meyer, Paul R. (1993). Reliability Issues in Holistic Assessment. *Assessing Writing: A Critical Sourcebook*. Eds. Brian Huot and Peggy O'Neill, 2009. Boston: Bedford/St. Martin's, pp. 29-56.

Cherryholmes, C. H. (1992). Notes on pragmatism and scientific realism. *Educational Researcher*, 13-17.

College Student Retention and Graduation Rates from 2000 through 2015. http://www.act.org/research/policymakers/reports/graduation.html. Accessed January 21, 2016.

Connors, R. J. (2004). The rise of technical writing instruction in America. In James M. Dubinsky (Ed.), *Teaching Technical Communication: Critical Issues for the Classroom*, Boston: Bedford/St. Martins, 77-98. Original work published 1982.

Coppola, Nancy W., and Elliot, Norbert. (2007). A technology transfer model for program assessment in technical communication. *Technical Communication*, *54*(4), 459-474.

Corbett, Steven J. (2014). Assessing Student Writing across the Curriculum: A literature review of assignment and rubric design for writing-intensive courses. *The Writing Campus* (online: Accessed November 17, 2015).

Crabtree, Benjamin F. and Miller, William L. (1999). *Doing Qualitative Research*. Thousand Oaks, CA: Sage Publications.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Dannels, Deanna P. (2003). Teaching and Learning Design Presentations in Engineering Contradictions between Academic and Workplace Activity Systems. *Journal of Business and Technical Communication*, 17(2), 139-169.

Davis, D. C., S. W. Beyerlein, and I. T. Davis. (2006). Deriving Design Course Learning Outcomes from a Professional Profile. *International Journal of Engineering Education* 22(1).

Duderstadt, James J. (2008) Engineering for a Changing World: A Roadmap to the Future of Engineering Practice, Research, and Education. *The Millennium Project*. The University of Michigan. Ann Arbor.

Ecclestone, K. (1999). Empowering or Ensnaring: The Implications of Outcome-based Assessment in Higher Education. *Higher Education Quarterly*, 53(1), 29-48.

Eisenhart, M. A., & Howe, K. R. (1992). Validity in educational research. *The handbook of qualitative research in education*, 643-680.

Eschenbach, Elizabeth, Eileen M. Cashman, Alisha Waller, and Susan M. Lord. (2005, October). Incorporating feminist pedagogy into the engineering learning experience. In *Frontiers in Education, 2005. FIE'05. Proceedings 35th Annual Conference* (pp. F4H-8-13). IEEE.

External Advisory Board report-out, Mechanical Engineering-Engineering Mechanics Department, Michigan Technological University, April 21, 2010.

Faigley, Lester, & Witte, Stephen. (1981). Analyzing revision. *College composition and communication*, pp. 400-414.

Fast Facts. http://www.mtu.edu/admissions/future/facts/. Accessed January 21, 2016.

Feldon, David F., Peugh, James, Timmerman, Briana E., Maher, Michelle A., Hurst, Melissa, Strickland, Denise, Gilmore, Joanna A., and Stiegelmeyer, Cindy. (2011). Graduate Students' Teaching Experiences Improve Their Methodological research skills. *Science*, 333(6055), 1037-1039.

Fereday, Jennifer and Muir-Cochrane, Eimear. (2006). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods*, 5(1), 80-92.

Fischer, Karin. Number of Foreign Students in U.S. Hit a New High Last Year. *Chronicle of Higher Education*. November 16, 2009. http://chronicle.com/article/Number-of-Foreign-Students-in/49142/

Flowerdew, John. (1999). Problems in writing for scholarly publication in English: The case of Hong Kong. *Journal of Second Language Writing*, 8(3), 243-264.

Foucault, Michel. (1971). The Discourse on Language. *The Archeology of Knowledge and the Discourse on Language*. New York: Pantheon Books, pp. 215-237.

Fulwiler, Toby. (1981, January). Showing, Not Telling, at a Writing Workshop. *College English*, 43(1), 55-63.

Fulwiler, Toby. (1986). Reflections: How Well Does Writing Across the Curriculum Work? *Writing Across the Disciplines: Research Into Practice*. Ed. Art Young and Toby Fulwiler. Upper Montclair, NJ: Boynton/Cook Publishers Inc., pp. 235-246.

Fulwiler, Toby and Young, Art. (Ed.). (1990). *Programs that work: Models and methods for writing across the curriculum*. Boynton/Cook Publishers Inc.

Gadamer, Hans-Georg. (1989). *Truth and Method*. Translation revised by Joel Weinsheimer and Donald G. Marshall. London: Continuum.

Gage, N.L. (1961). The Appraisal of College Teaching: An Analysis of Ends and Means. *Journal of Higher Education*, 32, 17-22.

Garrison, Catherine, and Ehringhaus, Michael. (2007). Formative and summative assessments in the classroom. Retrieved from http://www.amle.org/Publications/WebExclusive/Assessment/tabid/1120/Default.aspx on June 1, 2015.

Gee, James Paul. *Social Linguistics and Literacies: Ideology in Discourses*. Routledge, 2008, pp. 153-181.

General Criterion 3: Student Outcomes. (2014) retrieved from ABET Accreditation website (http://www.abet.org/DisplayTemplates/DocsHandbook.aspx?id=3143).

Gibbs, P., Angelides, P., & Michaelides, P. (2004). Preliminary thoughts on a praxis of higher education teaching. *Teaching in Higher Education*, Volume 9, Issue 2 April 2004 , pp 183-194.

Gottschalk, Katherine & Hjortshoj, Keith. (2004). *The elements of teaching writing: A resource for instructors in all disciplines*. Macmillan.

Gould, John D., & Lewis, Clayton. (1985). Designing for usability: key principles and what designers think. *Communications of the ACM*, 28(3), 300-311.

Grice, Henry P. (1968). Logic and Conversation. *The Semantics-Pragmatics Boundary in Philosophy* (2013). Eds. Maite Ezcurdia, Robert J. Stainton. Ontario, Canada: Broadview Press, pp. 47-59.

Halasz, Judith, Brincker, Maria, Gambs, Deborah, Geraci, Denise, Queeley, Andrea, & Solovyova, Sophie. Making it your own: Writing Fellows Re-evaluate Faculty "Resistance". *Across the Disciplines, 3*. (24 August 2006). Retrieved September 18, 2009, from http://wac.colostate.edu/atd/articles/halasz2006.cfm

Hamps-Lyons, Liz. The Challenges of Second-Language Writing Assessment. *Assessment of Writing*. Eds. Edward M. White, William D. Lutz, and Sandra Kamusikiri. The Modern Language Association of America. New York, (1996): pp. 226-240.

Haraway, Donna. (1991). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Simians, Cyborgs, and Women: The Reinvention of Nature*. New York: Routledge, pp. 183-202.

Harding, Sandra. (1991). *Whose Science? Whose Knowledge? Thinking from Women's Lives*. Ithaca, NY: Cornell University Press.

Hartsock, N. C. (1983). *Money, sex, and power: Toward a feminist historical materialism*. Boston: Northeastern.

Hedengren, Beth. (2004). *A TA's Guide to Teaching Writing in All Disciplines*. Boston: Bedford/St. Martin's.

Heidegger, Martin. (1993). Modern Science, Metaphysics, and Mathematics. *Basic Writings: From Being in Time (1927) to The Task of Thinking (1964)*. San Francisco: Harper.

Heidegger, Martin. (1993). The Way to Language. *Basic Writings: From Being in Time (1927) to The Task of Thinking (1964)*. San Francisco: Harper, 1993.

Huot, Brian & O'Neill, Peggy. (2009). *Assessing Writing: A Critical Sourcebook*. Macmillan.

Husserl, Edmund. The Vienna Lecture. *The Crisis of European Science and Transcendental Phenomenology: An Introduction to Phenomenological Philosophy*. Ed. David Carr.

Johnson, C. S. (2006). The analytic assessment of online portfolios in undergraduate technical communication: A model. *Journal of Engineering Education*, 95(4), 279-287.

Johnson, Glenn Ross. 1995. *First Steps to Excellence in College Teaching*. Atwood Publishing, pp. 104-105.

Johnson, R. (2004). Complicating technology: Interdisciplinary method, the burden of comprehension, and the ethical space of the technical communicator. *Teaching technical communication: Critical issues for the classroom*, , originally published in *Technical Communication Quarterly*,7(1), 24.

Kang, Okim & Donald Rubin. Listener Expectations, Reverse Linguistic Stereotyping, and Individual Background Factors in Social Judgments and Oral Performance Assessment (Book chapter for an upcoming untitled book, obtained via email communication with Dr. Rubin, October 1, 2013)

Katz, Steven B. (1992). The Ethic of Expediency: Classical Rhetoric, Technology, and the Holocaust. *College English*. 54:3, pp 255-275.

Klein, Julie Thompson. (1991). *Interdisciplinarity: History, Theory, and Practice*. Detroit: Wayne State University Press.

Klein, Julie Thompson. (1996). *Crossing Boundaries: Knowledges, Disciplinarities, and Interdisciplinarities*. Charlottesville: University of Virginia Press.

Knievel, Michael. (2006). Technology Artifacts, Instrumentalism, and the Humanist Manifestos Toward an Integrated Humanistic Profile for Technical Communication. *Journal of Business and Technical Communication*, 20(1), 65-86.

Kulik, James A., & McKeachie, William J. (1975). The evaluation of teachers in higher education. *Review of research in education*, 210-240.

Lambert, L. M., & Tice, S. L. (1993). Preparing Graduate Students To Teach. A Guide to Programs That Improve Undergraduate Education and Develop Tomorrow's Faculty. From *A Comprehensive National Survey of Teaching Assistant Training Programs and Practices*.

Lauer, Janice M. and J. William Asher. (1988). *Composition Research: Empirical Designs*. New York: Oxford University Press.

Liu, Jun. (2005). Chinese graduate teaching assistants teaching freshman composition to native English speaking students. *Non-Native Language Teachers: Perceptions, Challenges, and Contributions*, Springer US.

Mansilla, V. B. (2005). Assessing student work at disciplinary crossroads. *Change: The Magazine of Higher Learning*, 37(1), 14-21.

Marincovich, M., Prostko, J., & Stout, F. (1998). *The Professional Development of Graduate Teaching Assistants*. Bolton, MA: Anker Publishing Co.

Marsh, Herbert. (1984). Students' Evaluations of University Teaching: Dimensionality, Reliability, Validity, Potential Biases, and Utility. *Journal of Educational Psychology*, 76(5), 707-754.

Marsh, Herbert W. and Roche, Lawrence A. (1997). Making Students' Evaluations of Teaching Effectiveness Effective. *American Psychologist*, 52(11), 1187-1197.

Matsuda, Paul Kei and Silva, Tony. Cross-Cultural Composition Mediated Integration of U.S. and International Students. *Composition Studies*. 27:1 (1999): pp. 15-30.

Maum, R. (2002). Nonnative-English-Speaking Teachers in the English Teaching Profession. *ERIC Digest*.

MEEM 2500 Integrated Design and Manufacturing ABET Course Syllabus.

MEEM 3000 Mechanical Engineering Laboratory ABET Course Syllabus.

MEEM 3220 Energy Lab ABET Course Syllabus.

Merleau-Ponty, Maurice. (1989). *Phenomenology of Perception*. London: Routledge.

Merriam, Sharan B. (1998). *Qualitative Research and Case Study Applications in Education*. San Francisco: Jossey-Bass.

Michigan Technological University. Assessment Overview. http://www.mtu.edu/assessment/program/approach/. Accessed February 28, 2015.

Michigan Technological University Institutional Analysis Enrollment Statistics website. http://www.admin.mtu.edu/ia/student/enrollment/.html

Michigan Technological University Student Learning Goals website. http://www.mtu.edu/assessment/program/university-learning-goals/. Accessed June 1, 2015.

Miller, Carolyn R. (1979). A Humanistic Rationale for Technical Writing. *College English*. 40:6: pp 610-617.

Moore, P. (2004). Myths about instrumental discourse: A response to Robert R. Johnson. *Teaching technical communication: Critical issues for the classroom*, originally published in *Technical Communication Quarterly*, 8(2), 45.

Moore, Patrick. (2004). Questioning the Motives of Technical Communication and Rhetoric: Steven Katz's 'Ethic of Expediency'. *Journal of Technical Writing and Communication*, 34(1), 5-29.

Morgan, Meg. (2002). The GTA Experience: Grounding, Practicing, Evaluating, and Reflecting. *The Writing Program Administrator's Resource*, 393-410.

Morphew, Christopher C. and Harley, Matthew. (2006, May/June). Mission Statements: A Thematic Analysis of Rhetoric Across Institutional Type. *Journal of Higher Education*, 77(3), 456-471.

Moskal, B. M. and Leydens, J. A. (2000). Scoring rubric development: Validity and reliability. *Practical assessment, research & evaluation*, 7(10), 71-81. Online. Accessed from http://pareonline.net/getvn.asp?v=7&n=10 on October 29, 2014.

Niglas, K. (2004) *The Combined Use of Qualitative and Quantitative Methods in Educational Research*. Tallinn, Estonia: Tallinn Pedagogical University Dissertation on Social Sciences.

Nyquist, Jody D. (1991). *Preparing the Professoriate of Tomorrow to Teach. Selected Readings in TA Training*. Dubuque, IA: Kendall/Hunt publishing Company.

Olds, B.M., Moskal, B.M., and Miller, R.L., Assessment in Engineering Education: Evolution, Approaches, and Future Collaborations. *Journal of Engineering Education*, Vol. 94, No. 1, 2005, pp. 13–25.

Park, Chris. (2004). The Graduate Teaching Assistant (GTA): Lessons from North American Experience. *Teaching in Higher Education*, 9(3), 349-357.

Petraglia, Joseph. (1995). Spinning like a kite: A closer look at the pseudotransactional function of writing. *JAC*, 19-33.

Phillipson, Robert. (1992). ELT: the native speaker's burden? *ELT Journal*, 46(1), 12-18.

Prieto, Loreto R. and Steven A. Meyers. (1999). Effects of Training and Supervision on the Self-Efficacy of Psychology Graduate Teaching Assistants. *Teaching of Psychology*. 26(4), 264-266.

Rodrigue, T. K. (2012). The (in) visible world of teaching assistants in the disciplines: Preparing TAs to teach writing. *Across the Disciplines*, 9(1). Accessed online, Feb. 18, 2015.

Rubin, Donald L. (1992). Nonlanguage Factors Affecting Undergraduates' Judgments of Nonnative English-Speaking Teaching Assistants. *Research in Higher Education*, 33(4), 511-531.

Russell, David. (2002). *Writing in the Academic Disciplines: A Curricular History*. Carbondale: Southern Illinois University Press.

Spinuzzi, Clay. (2004). Pseudotransactionality, activity theory, and professional Writing instruction. In J. Dubinsky (Eds.), *Teaching Technical Communication: Critical Issues for the Classroom* (pp. 337–347). Boston: Bedford/St. Martin's. (Reprinted from *Technical Communication Quarterly* 5(3), 1996, 295–308).

Spooner, Michael and Holly O'Donnell, H. (1987). From Cheap Labor to Junior Colleague: Training TAs in Composition. English Education. *ERIC/RCS Report*, 122-126.

Stajkovic, Alexander D., and Luthans, Fred. (1998). Self-efficacy and work-related performance: A meta-analysis. Psychological bulletin, 124(2), 240.

Steinmetz, George. (Ed.) (2005). *The politics of method in the human sciences: Positivism and its epistemological others*. Duke University Press.

Taylor, Marcy and Holberg, Jennifer L. (1999). "Tales of Neglect and Sadism": Disciplinarity and the Figuring of the Graduate Student in Composition. *College Composition and Communication*, pp. 607-625.

Taylor, Summer Smith. (2007). Comments on Lab Reports by Mechanical Engineering Teaching Assistants Typical Practices and Effects of Using a Grading Rubric. *Journal of business and technical communication*, *21*(4), 402-424.

Tenopir, Carol & Donald W. King. *Communication Patterns of Engineers.* Hoboken, NJ: Wiley, 2004. Print.

Van Note Chism, Nancy. (1998). Preparing Graduate Students to Teach: Past, Present, and Future. *The Professional Development of Graduate Teaching Assistants*. Eds. Marincovich, M., Prostko, J., & Stout, F. Bolton, MA: Anker Publishing Co.

http://wac.colostate.edu/intro/pop2e.cfm. What is Writing in the Disciplines? Accessed September 1, 2015.

http://wac.colostate.edu/intro/pop3a.cfm. Basic Principles of WAC. Accessed September 1, 2015.

Wardle, E. (2007). Understanding ‘transfer’ from FYC: Preliminary results of a longitudinal study. *Writing Program Administration*, 31(1/2), pp. 65-85.

Weicheng, Zou. (Summer 2003). Bridging Cultural Differences in College Selection and Application: Incorporating College Selection Into a Language Curriculum for Chinese Students. *Journal of College Admission*, 180: 7-17.

Weiler, Kathleen. (1988). *Women Teaching For Change: Gender, Class & Power*. New York: Bergin & Garvey Publishers.

Weisse, Robert S. (1994*). Learning From Strangers: The Art and Method of Qualitative Interview Studies*. New York: The Free Press.

White, Edward. (1996). Power and Agenda Setting. *Assessment of Writing*. Eds. Edward M. White, William D. Lutz, and Sandra Kamusikiri. The Modern Language Association of America. New York, pp. 9-24.

White, Edward M. (2007). *Assigning, Responding, and Evaluating: A Writing Teacher’s Guide*. Boston: Bedford/St. Martins.

Williamson, Michael. (1994). The Worship of Efficiency: Untangling Theoretical and Practical Considerations in Writing Assessment. *Assessing Writing: A Critical Sourcebook*. Eds. Brian Huot and Peggy O'Neill, 2009. Boston: Bedford/St. Martin's, pp. 57-80.

Wilson, Maja. (2006). *Rethinking Rubrics in Writing Assessment*. Portsmouth, N.H.: Heinemann.

Winsor, Dorothy. (1996). *Writing Like an Engineer*. New York: Routledge.

Wirtz, Ronald A. (2014, April). Flying Colors: International Students Flock to Ninth District Universities. *Fedgazette*, 9-12.

Worthington, Andrew C. (2002). The Impact of Student Perceptions and Characteristics on Teaching Evaluations: A Case Study in Finance Education. *Assessment and Evaluation in Higher Education*, 27(1), 49-64.

Wyckoff, Susan. (2001). Changing the culture of undergraduate science teaching. *Journal of College Science Teaching*, 30(5), 306-312.

Yancey, Kathleen Blake, & Huot, Brian. (1998). Construction, deconstruction, and (over) determination: A Foucaultian analysis of grades. *The theory and practice of grading writing: Problems and possibilities.* Albany: State University of New York Press.

Yorke, M. (2003). Formative assessment in higher education: Moves towards theory and the enhancement of pedagogic practice. *Higher education*, 45(4), 477-501.

Young, Art and Fulwiler, Toby. Eds. (1986). *Writing Across the Disciplines: Research Into Practice*. Upper Montclair, NJ: Boynton/Cook Publishers Inc.

Young, Art. (2012). Writing Across and Against the Curriculum. *Writing Across the Curriculum: A Critical Sourcebook*, Eds. Terry Myers Zawacki and Paul M. Rogers. Boston: Bedford/St. Martins.

Appendix A

Course & Learning Outcomes	Relationship to ABET Outcomes	Course Description and structure
MEEM 2500 Integrated Design & Manufacturing 1. Be able to select a suitable manufacturing process (or sequence of the processes) for a given part design. 2. Be able to do force and power calculations for forming and machining processes. 3. Be able to suggest design changes that improve manufacturability. 4. Become familiar with the product development process. 5. To understand the capabilities of various manufacturing equipment.	An ability to communicate descriptively and effectively-moderate. Activities: Students complete written weekly laboratory reports.	Focuses on practical aspects of design and manufacturing. Covers fundamentals of manufacturing processes and includes weekly lab providing hands-on experiences with manufacturing issues that influence component design. Incorporates computer aided manufacturing tools. 14 labs
MEEM 3220 Energy Lab 1. To gain an understanding of the basics of statistics, uncertainty, and regression analysis. 2. To gain insight to the basics of measuring the fundamental properties. 3. To learn sensor calibration, data acquisition, and data processing. 4. Hands-on experience with industrial hardware and working in small groups. 5. To practice various forms of technical communication	An ability to communicate ideas effectively-High Importance Activities: Emphasis on technical communication in the form of written reports, data plotting, and discussion technical memos, and oral presentations.	Introduction to transducers and the use of transducers to reinforce knowledge in the application of the principals of Thermodynamics, Fluid Mechanics, and Heat transfer. 11 labs
MEEM 3000 Mechanical Engineering Lab Students who successfully complete this course will have obtained laboratory skills in the measurement and analysis of static and dynamic phenomenon related to typical mechanical engineering topics. They will have had a reinforcement of concepts presented in Dynamics, Mechanics of Material, Thermal Sciences, and Dynamic Systems through appropriate laboratory experiments and/or demonstrations. They will have worked in teams that produce written reports that present the details and results of the experiment, as well as conclusions drawn for the measured data.	An ability to communicate ideas effectively- High importance activities: The Students prepare lab reports. Each student must describe and interpret their own results.	Presents basic laboratory skills, including analog and digital data acquisition, Transducer selection and calibration, laboratory safety, and application of statistical principals to experimental data. Presents concepts of investigating phenomenon through observation and interpretation of acquired data. Reinforces concepts in Statics, Strength of materials, Thermodynamics, Fluid mechanics and Dynamics. 3 instructors, 3 GTAs for 3 topics (Thermal sciences, Dynamic systems, and solid mechanics). Each topic lasts for 3 weeks, with the first 3 weeks focusing on general lab skills.

Appendix B

MEEM Lab Report Guidelines

For use in MEEM 2500, MEEM 3000, and MEEM 3220

Prepared by Nancy Barr

Collaborators:

Mike LaCourt, MEEM 2500 Course Coordinator

Dr. Jason Blough, MEEM 3000 Course Coordinator

Dr. Chuck Margraves, MEEM 3220 Course Coordinator

Dr. James De Clerck, MEEM 3000 Dynamics Systems Instructor

Dr. L. Brad King, MEEM 3000 Heat Transfer Instructor

Dr. Ibrahim Miskioglu, MEEM 3000 Solid Mechanics Instructor

Timothy Jenkins, MEEM 2500 Lab GTA

John Armstead, MEEM 3220 Lab GTA

Fall 2012

TITLE PAGE

The title page must include the name of the course, the title of the experiment, your name, the names of the TA and the instructor, and the date. Also, list the names of the students in your lab group when you collected the data.

ABSTRACT

This is a short (less than 200 words) summary of the experiment and conclusion. It should contain three elements: (1) the purpose of the experiment, (2) a description of key findings, and (3) major conclusions. Often abstracts can include brief descriptions of the methods used or some theoretical background. The abstract is the **last** section written, after the experiment is complete and you have written your analysis and conclusions.

Sample Abstract:

An electron trapping apparatus was constructed to emulate the electric and magnetic fields found in a Hall-effect thruster in order to investigate cross-field electron mobility. Anomalous mobility was previously observed in this device that is orders of magnitude higher than classical. The focus of this manuscript is to investigate the effect of neutral density on the electron temperature and cross-field mobility in the electron trap. It was found that electron temperature decreases with increasing neutral density. When electron temperature is taken into account in the calculation of classical mobility, trends are observed in this device that resemble classical scaling with neutral density; however, the magnitude of the observed mobility is 100 to 1,000 times higher than classically predicted. On further investigation of the electron temperature, it is determined that in some cases the electron temperature is much higher than would be possible if collisions were responsible for transport, as inelastic collisions, which prevail at higher electron energies, would cause electron cooling that is not seen here. Furthermore, an examination of the probe I-V characteristic reveals that the electron distribution function is highly non-Maxwellian in these cases, supporting a collisionless anomalous mobility.

1. BACKGROUND AND OBJECTIVE(S)

This section details any theoretical or historical background the reader will need to understand your data and results, which are presented later in the report. For example, if your experiment were to measure the efficiency of a heat exchanger, you would describe the fundamental theory of heat exchangers including any equations you will use later in the report. If your experiment were to measure the elastic modulus of steel, you would explain the concept of elastic modulus and its use.

Labeling the equation enables you to refer to it in the text of the report. **Explain all variables in the engineering diagrams and equations!** Hand-written equations are not acceptable, except in the Appendix (sample of appropriate format of hand calculations is attached). Within the body of the lab report, equations written in standard typeset (like computer code, e.g. y=R1^2*cos(x)) are also not acceptable. You must learn to use a proper typesetting tool such as Microsoft Equation Editor. You should number each equation in the right margin so you can refer to it later in the text by number.

The format for inserting an equation is as follows:

$$y = mx + b \tag{0.1}$$

$$f(t) = M\frac{dx^2}{d^2t} + C\frac{dx}{dt} + Kx \tag{0.2}$$

Cite references that would help the reader understand the experiment's theoretical foundation. In the first example, you could briefly explain the concept behind heat exchangers in a paragraph and then refer the reader to pages in a textbook or lab manual that provide more detail.

The final paragraph of this section should state, in a concise and precise manner, the goal of your experiment. Be clear and direct so there is no question about the purpose of the experiment and the subsequent report.

2. APPARATUS

Describe any hardware or setup used in your experiment. While not required, it is good practice to include a block-diagram schematic of all your components showing how they are connected. If you are simply reproducing a setup that is explained elsewhere (lab manual), you can reference that document instead of reproducing the figure. You do not need to fully derive every theory or equation. It is, however, helpful to include engineering diagrams and equations to explain data. The one example of an engineering diagram is a block diagram, shown in Figure 1.

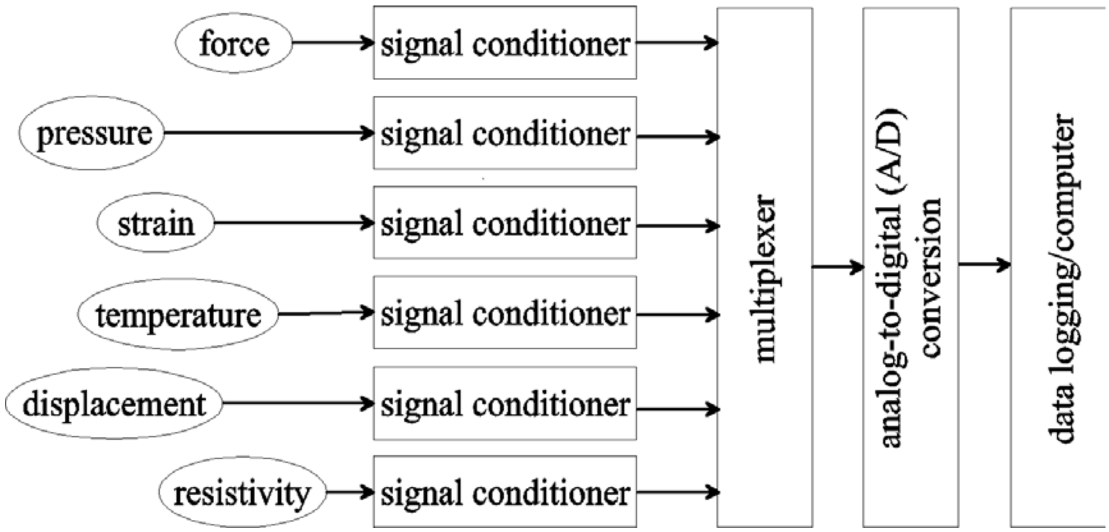

Figure 1: Block diagram of the acquisition and storage of multiple transducer signals

3. EXPERIMENTAL PROCEDURES

Describe your experimental procedure in chronological order and include any settings, gains, voltages, etc. that were used. It is, however, sufficient to cite the lab manual and only comment on anything that may be different from the instructions in the lab manual. Often the procedure in the lab manual is lacking in some details so be sure to include any important details, precautions and warnings and decisions that have been made during the experimentation. Remember, the idea here is to document exactly how you performed the experiment (validation) and then provide instructions so that anyone can repeat your experiment exactly and get similar results.

4. MEASUREMENT/DATA SUMMARY

Report your results–which means what you actually and directly measured in this experiment–in this section. Results can be reported in graphical format, as tabular data values, etc. The important thing is to show the raw or calibrated data before you apply any analyses. In the event you have large tables or lots of unprocessed data you can include representative data in this section, then provide the remaining data in an appendix to ease reading. Think of this section as “reporting the facts.” Your job is to report, clearly and without opinion, your measurements. You will make interpretations based on these measurements in the next section.

Discribe basic quality checks on your data. How do you know that the unprocessed data are”good?” Identify and describe:

- Data quality checks that you did during the experiment and before you left the lab
- Potential anomalies in the unprocessed data
- Sources of error in the unprocessed data

As an example: if the goal of your experiment was to measure the heat transfer efficiency of a tube-in-tube heat exchanger you would report your inlet temperature, outlet temperature, and mass flow rate in this section. Describe your thought process to ensure that your data represent the measurands. You would not show calculations for the device efficiency until the next section.

5. INTERPRETATION AND ANALYSIS

This section should contain a thorough analysis of that data, describing "what happened." This is the most important part of your report. In this section you will use your engineering/scientific expertise to interpret the results and analyze their meaning. The numbers calculated and any graphs and figures that show the results of those calculations (not raw data) are presented here. It may be necessary to separate this into several subsections in cases where there is more than one data set obtained during experimentation. **Not all the intermediate calculations need to be in this section, but any calculated values are shown along with the equations from which they were calculated.** If tabulated data is calculated from the raw measurements, then a complete data table should be shown here (see Table 1 as an example) Think of it as having the complete table filled out from the lab manual.

A figure number and title must accompany each graph as well as the tables. A figure or table should essentially stand alone, that is, one can read and understand it without the rest of the report. Thus, each figure must have a caption along with the figure title placed under the figure. Each table must be labeled and numbered, with a label placed above the table. Additionally, each column and/or row must be labeled. Any graphs should have each axis labeled and the appropriate units noted. For MEEM 2500, remember to also include the material tested (i.e. Al 6061-O) in the title. You still must also reference the figure or table and discuss the figure or table in the text of the report. **In fact, it is imperative that each figure and table be discussed in the text of the report.**

Next, use your engineering/scientific expertise to interpret the results and analyze their meaning. Often you will take data from your results and combine them in some way to calculate a parameter of interest (e.g. use inlet temperature, outlet temperature, and mass flow to calculate heat transfer efficiency). You will then comment on the meaning of these analyses and give subjective, yet justified, discussion of their meaning. In this section, you might:

- Compare your results to those of another experiment
- Explain whether or not your results were what you expected
- Analyze possible experimental error and estimate its impact

- Relate your results with the stated objective of your experiment

Example of properly formatted table:

Table 1: Pressure loss test results for the enhanced (DX) tube

Enhanced Tube Test #2				
Weir Head (inches)	Volumetric Flow Rate (GPM)	Mass Flow Rate (slugs/s)	ΔP Average (psi)	DP / Unit Length (psi/ft)
3 3/16	23.38	0.1074	1.5017	0.6436
2 1/2	12.74	0.0585	0.3960	0.1697
1 7/32	2.11	0.0097	0.0121	0.0052

6. CONCLUSIONS

The conclusion should state the indisputable outcomes of this experiment and justify that all objectives were completed. For example, "the force/deflection diagram exhibited a linear behavior consistent with elastic theory." There should be no new data presented in this section. You may, however, make recommendations on improving the experiment in the future such as suggestions for changes in procedures or types of instrumentation used.

REFERENCES

References point the reader to the sources you used to complete your work. You must cite all work that is not your own. For example, you will likely cite the lab manual, relevant textbooks, and maybe even a scientific paper. Engineers and scientists typically use a numeric style of referencing such as IEEE (see this website or others [Google search] for formatting questions:

- http://www.ieee.org/documents/ieeecitationref.pdf
- http://www.ijssst.info/info/IEEE-Citation-StyleGuide.pdf

References are numbered in order of appearance in the text, beginning with [1], are placed within the last punctuation mark of the sentence, and each number corresponds to a full citation listed in this section. Include only references that are referenced by number in the text. Do not include extra references as you would in a bibliography. An example list of references is shown here.

1. J. P. Holman, *Experimental Methods for Engineers*, 7th Ed, McGraw-Hill (2001).
2. J. Doe and R. Hill, *Journal of the Electrochemical Society*, 137, 1902 (1990).

3. F. P. Fehlner, *Low Temperature Oxidation: The Role of Vitrous Oxides*, p. 23, Wiley Interscience, New York (1986).
4. N. J. DiNardo, in *Metallized Plastics 1*, K. L. Mittal and J. R. Susko, Editors, p. 137, Plenum Press, New York (1989).

APPENDIX

Any information placed in the appendix must be cited in the body of the report. For example, in the analysis section, you might say, "All Matlab calculations are located in Appendix A."

Appendix A should contain all your computer-generated calculations. If there are any supplemental EES, Matlab, CFD computations that can accompany your report place them in their own Appendices before any hand written calculations and before your data sheet.

Appendix B includes pages of hand calculations, which you should include on nearly all labs. Remember, the final values and original equations must be reported in the data analysis section. The rest of the calculations should be attached as an appendix.

Additionally, you should always have at least the data table from the lab manual that you completed by hand attached as an appendix. This is proof of the data you collected.

Do not include:

- A copy of the lab manual
- Any other provided instructions
- Hundreds of data points already represented in plots in the body of the report.

SOME GENERAL NOTES ON PROPERTIES OF WELL-WRITTEN LAB REPORTS

Format - All reports should be formatted in Times New Roman 12-point font with 1"margins all around and contain the page number at the bottom of each page except the title page.

Concise and Precise Language–Concise writing is direct and active, with no "fluff." Fluff writing contains too many words that do nothing to inform the reader of your purpose and results. Also, never use phrases such as "due to the fact that," "first and foremost," or "oftentimes" because they only obscure meaning. Also, avoid adverbs, which are parts of speech that modify verbs. They often end in -ly and are unnecessary in technical writing. Precise language is never vague. Words or phrases such as "some," "a few," "several," "very," "many" and any phrases that begin with "this" as in "this data" have no place in an engineering report. State your results in clear, quantitative language or numbers. Also, avoid the use of personal pronouns such as *I* or *we*.

The following sentence is wordy and imprecise.

The reason the stuff turned to liquid was due to the fact that the temperature went above zero degrees Celsius about an hour after we started.

A more effective sentence is:

The ice on the plate turned to liquid when the air temperature exceeded 0° C fifty-five minutes into the experiment.

Figures and Tables–All figure and tables must:

- Have a numbered caption and a meaningful title
- Be reference in the text by caption number
- Be placed in the document at the next paragraph break after it is referenced in the text (eliminating the need to direct the reader "above" or "below").

Figures must be clear and legible. The caption, figure number and meaningful title (Figure 1. Deflection diagram of aluminum beam) should be centered beneath the figure. If the figure/labels/traces are unreadable do not blame your computer program, e.g. Excel or Word. Find a better program.

The data plots require that all axes are labeled and include proper units. Also, resist the urge to "connect the dots" in your plots with a curve, even though many graphing programs try to do this by default. "Dots" in experimental data have a very precise meaning: They say, "this is exactly where I made a measurement." Figure 2 is an example of a situation where it would **NOT** be appropriate to connect the data points. The reader is fully aware that you made seven measurements. He/she knows that interpolating between the measurements is risky because it was not measured in the experiment.

Tables must also be clear and legible. The caption, table number and meaningful title (Table 1: Pressure loss test results for the enhanced (DX) tube) should be centered above the table.

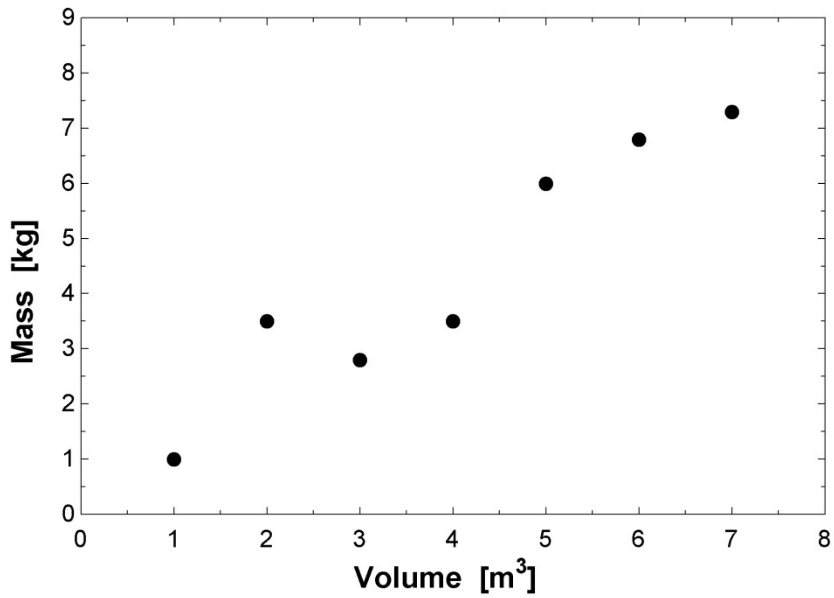

Figure 2: Example of a plot with the experimental data appropriately NOT connected.

There are situations that connecting the data points does become appropriate because it would add clarity to the data plot. For example, if there is a large quantity of meticulously collected data points that follow a distinct trend, then the data points should be connected. Figure 3 is an example of a situation where it would be appropriate to connect the data points. If this set of data were plotted with individual dots, the overlapping dots would reduce the clarity of subtle changes in the trend.

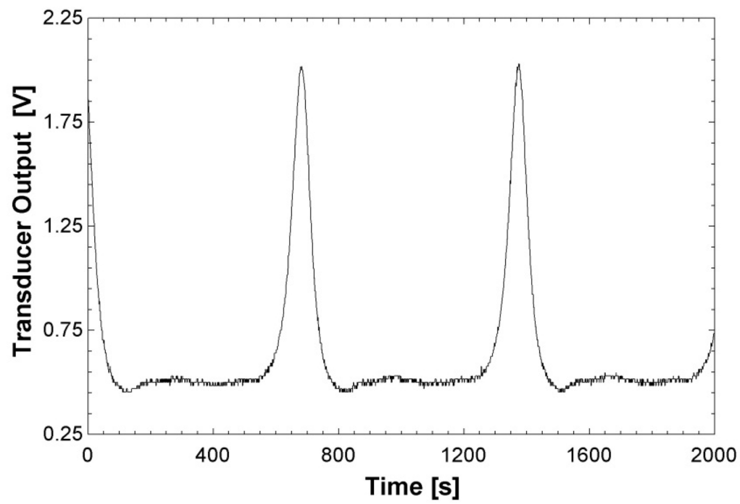

Figure 3: Example of a plot with the experimental data appropriately connected.

Data–Use proper scientific procedure to determine the correct number of significant figures. Do not simply report 12 decimal places because Matlab printed them out for you.

Writing Style–Quality enginnering documents have clear and concise writing style. The Purdue Online Writing Lab (OWL) is an excellent resource for for developing writing skills. Start with these links to specific respources:

- Purdue Online Writing Lab (OWL) - http://owl.english.purdue.edu/
- Style of Writing - http://writingcenter.unc.edu/handouts/style/
- IEEE Editorial Style - http://www.ieee.org/documents/stylemanual.pdf
- Grammar - http://owl.english.purdue.edu/owl/section/1/5/
- Punctuation - http://owl.english.purdue.edu/owl/section/1/6/
- Figures - http://owl.english.purdue.edu/owl/resource/560/20/
- Tables - http://owl.english.purdue.edu/owl/resource/560/19/

Appendix C

ME-EM LAB REPORT RUBRIC						
	Exceptional	**Good**	**Acceptable**	**Poor**	**Unacceptable**	**Points**
Title Page	Contains all required elements listed in the ME-EM Lab Report Guidelines	N/A	N/A	N/A	Incomplete	5
Abstract	In addition to "good" criteria, the abstract is written in clear, concise language and accurately captures the point of the experiment.	Contains the purpose of the experiment, a description of key findings, and major conclusions.	Key elements are presented but language is vague or wordy.	Missing one of the three key elements as listed in ME-EM Lab Report Guidelines or exceeds about 200 words.	Incomplete	5
Background & Objectives	In addition to the "good" criteria, the section is clear, concise, and describes the history and theory supporting the experimental work.	Contains theory and/or history behind the experiment. All variables and schematics are explained and labeled properly in the text. Objectives of the experiment are clear.	Brief background information is presented and objectives are included but contain few details that engage the reader in the experiment.	Incomplete. Writer uses informal or vague language to explain background, equations, or objectives.	Incomplete	10
Apparatus	Concise explanation of the apparatus used in the experiment. Includes an attractive schematic of the equipment involved.	N/A	Describes the apparatus used but is not written in clear, concise language. May not include graphics.	Incomplete. Writer uses informal or vague language to explain objectives.	Incomplete	5
Experimental Procedures	Contains (or cites) clear instructions on how to perform the lab experiment. Includes key details on any aspect that differs from the procedure outlined in the lab manual.	N/A	Key procedural elements are included, but lack sufficient detail. Assumes reader is familiar with apparatus and experiment set-up.	Incomplete. Writer uses informal or vague language to explain objectives or copies procedures from the manual without citation or further explanation.	Incomplete	5
Measurements/ Data Summary	Sufficient data is presented to establish that the results are accurate. Includes a discussion on data accuracy.	N/A	All data are presented but lack sufficient detail. [Half Credit]	N/A	Incomplete	5
Interpretation and Analysis (Written)	Contains concise, yet thorough analysis of those results. All data tables and figures are easy to read and properly labeled.	N/A	All data tables and figures are easy to read and properly labeled.	Contains incomplete analysis. Writer uses informal or vague language to describe the data.	Incomplete	5
Interpretation and Analysis (Deliverables)	Correct with proper units (if required)	N/A	Reasonably correct results with justification, proper units, and precision (if required).	N/A	Incomplete	30
Conclusion	Provides description of all outcomes, justification that all objectives were met, and any additional information requested, e.g. ways to improve experiment.	N/A	Provides description of all outcomes and justification that all objectives were met but lacks sufficient detail. Contains no new information.	Does not provide descriptions for all outcomes or justification that all objectives were met. Contains new data that should be in the body of the report.	Incomplete	15
References	In addition to "acceptable" criteria, student demonstrates extra effort in seeking related references beyond the lab materials.	N/A	All ideas that are not your own are cited in the text with corresponding full citations in the reference section, using IEEE citation style.	Incomplete or in the wrong format (MLA or APA).	Incomplete	5
Appendix	All appendices are labeled and referred to in the text of the report so the reader knows the information is in the appendix. All hand calculations and figures are readable.	N/A	Contains information that should be in the body of the report. [Half Credit]	N/A	Incomplete	5
Formatting	Complies with lab report format guidelines	N/A	N/A	Exceeds the page limit (8 pages not counting the title and reference pages) and/or formatting is incorrect.	Incomplete	5
						100

Appendix D

MEEM 3220 Energy Lab Student Survey

Prepared by Nancy Barr, ME-EM Communications Adviser

Purpose: The purpose of this survey is to obtain feedback from you, the students, on the addition of a detailed set of guidelines and corresponding rubric to the course and the results of a new training program for lab graduate teaching assistants. Please complete BOTH PAGES.

Specifically, we want to know the following:

1. Did the guidelines improve your understanding of the requirements for the lab reports? Why or why not?

2. Did the rubric improve your understanding of the requirements for the lab reports? Why or why not?

3. Was the grading consistent with the instructions in the guidelines? If not, please describe any inconsistencies.

4. Was the grading consistent with the rubric? If not, please describe any inconsistencies.

5. Did the GTA's feedback on the lab reports help you learn, e.g. did you have a better understanding of the expectations after reviewing the GTA's feedback?

6. What improvements would you suggest to make the guidelines/rubric more effective?

7. What improvements would you suggest to make the GTA feedback more effective?

Data Use: The results will be used to evaluate the effectiveness of the guidelines/rubric and the GTA training. It might also be used in future publications about the program. We have obtained an IRB waiver for the GTA Lab Training Program and related surveys.

Appendix E

THEMES FOR EACH QUESTION						
Question 1 Did the guidelines improve your understanding of the requirements for the lab reports? Why or why not?	**Question 2 Did the rubric improve your understanding of the requirements for the lab reports? Why or why not?**	**Question 3 Was the grading consistent with the instructions in the guidelines? If not, please describe any inconsistencies?**	**Question 4 Was the grading consistent with the rubric? If not, please describe any inconsistencies.**	**Question 5 Did the GTA's feedback on the lab reports help you learn, e.g. did you have a better understanding of the expectations after reviewing the GTA's feedback?**	**Question 6 What improvements would you suggest to make the guidelines/rubric more effective?**	**Question 7 What improvements would you suggest to make the GTA feedback more effective?**
Theme 1 Ease of Use	Theme 1 Yes, but lab manual was more helpful for actual	Theme 1 Yes, and feedback was helpful	Theme 1 Yes, grading was consistent w/ the rubric	Theme 1 Yes, but seeing TA in person was as, or more, effective	Theme 1 More detailed, less vague explanations	Theme 1 More feedback
Theme 2 Showed Structure/format/requirements	Theme 2 Yes, as a final check before turning it in	Theme 2 Yes, but feedback was not detailed enough	Theme 2 No, not consistent	Theme 2 Yes, but first report should be graded less harshly	Theme 2 More consistency between guidelines/rubric and evaluation	Theme 2 Comment on things done well
Theme 3 Not helpful, did not use, or unsure	Theme 3 Yes, with Guidelines as helpful or moreso	Theme 3 No, grading was inconsistent from week to week	Theme 3 TA just skimmed report	Theme 3 No, because TA was inconsistent	Theme 3 Improve consistency between guidelines , rubric, and lab manual	Theme 3 Show how to fix rather than just mark wrong
Theme 4 Knowing what TA looking for (what would be assessed)	Theme 4 No, not detailed enough	Theme 4 Yes, grading was fair/consistent	Theme 4 Yes, but feedback was not helpful	Theme 4 Yes, when it was provided	Theme 4 Improve consistency between GTAs	Theme 4 More feedback on local issues, e.g. grammar, sentence structure, word choice
Theme 5 Increased Efficiency	Theme 5 No, it was inaccurate, hard to follow	Theme 5 TA answered questions about grading with good reasons	Theme 5 Yes, and feedback was helpful	Theme 5 No, because feedback was vague	Theme 5 More lenient grading	Theme 5 Feedback written on the reports, not just the Canvas rubric
Theme 6 Not specific enough or unclear	Theme 6 Yes, easy to understand what needed to be covered	Theme 6 No, TA did not follow the guidelines	Theme 6 Does not agree with the rubric points structure	Theme 6 No, because amount of feedback was inconsistent	Theme 6 Increase flexibility in category options in rubric	Theme 6 No improvement needed
Theme 7 Worked in tandem with feedback	Theme 7 Yes, in connection with the feedback	Theme 7 Too harsh grading	Theme 7 Grading policy was fair	Theme 7 No, because there was no feedback	Theme 7 Allow for resubmission	Theme 7 More lab prep by the TA so the TA understands the lab
Theme 8 TA did not follow	Theme 8 Did not use	Theme 8 No, too much inconsistency between GTAs	Theme 8 Harsh grading	Theme 8 Yes, to clarify TA's expectations	Theme 8 Include a check-off (quiz) so students are forced to read the guidelines (grade their own work first)	Theme 8 Have Tas take their jobs more seriously
Theme 9 Easier to use than rubric	Theme 9 TA did not adhere to rubric	Theme 9 Yes, but inconsistent from GTA to GTA	Theme 9 No, and feedback was not helpful	Theme 9 No	Theme 9 Include the guidelines/rubric in each week's lab manual	Theme 9 Let students resubmit to earn back points and make improvements
Theme 10 Not as helpful as the rubric or used in tandem with rubric	Theme 10 Yes, but TA graded too harshly	Theme 10 Did not know what the "Guidelines" were, did not use, or did not understand the question	Theme 10 Rubric not clear on differences between categories or categories vague	Theme 10 Liked the electronic submission	Theme 10 Include formatting requirements in the guidelines (we did this)	Theme 10 More lenient grading
Theme 11 Too much discrepancy between Tas	Theme 11 Yes, but feedback not helpful	Theme 11 Did not like the guidelines (too vague, too general, etc.)	Theme 11 TA listened to my questions	Theme 11 Yes, because TA's feedback was detailed	Theme 11 Include an example lab report in the guidelines	Theme 11 Be consistent with guidelines/rubric
Theme 12 Yes (no explanation)	Theme 12 Yes, but points spread too wide and/or feeback too	Theme 12 No, and feedback was not helpful	Theme 12 Each TA interpreted rubric differently	Theme 12 Feedback was insulting	Theme 12 No improvements needed	Theme 12 Return grades and feedback more quickly
Them 13 Yes, but too much detail included	Theme 13 No, too much inconsistency between GTAs	Theme 13 Yes, but too much emphasis on formatting by GTAs	Theme 13 Student did not look at rubric or not sure	Theme 13 No, because feedback came too late	Theme 13 Have GTAs explain how they interpret guidelines/rubric and how to find the rubric and feedback	Theme 13 Have GTAs supply a sample high-quality lab report
Theme 14 Yes, but would like to see sample lab report	Theme 14 Yes, as a source of feedback in Speedgrader		Theme 14 Yes, but too much emphasis on formatting	Theme 14 Yes, but amount and quality of feedback varied from TA to TA	Theme 14 Require GTAs to give feedback when points are deducted	Theme 14 Make it easier to locate feedback
Theme 15 Did not seem to understand the question or referred to lab manuals or feedback instead of the	Theme 15 Yes, so I know points for each section so I know where to focus attention			Theme 15 Could not find feedback on Canvas	Theme 15 Do not change either once semester has started	Theme 15 Allow for more personal interaction between GTAs and students

Appendix F

University Student Learning Goal 5A: Written Communication Rubric

Students will be able to communicate effectively, orally, in writing and in new media, to a wide variety of audiences. **Written communication** is the development and expression of ideas in writing. Written communication involves learning to work in many genres and styles. It can involve working with many different writing technologies, and mixing texts, data, and images. Written communication abilities develop through iterative experiences across the curriculum.

Written Communication	What is being assessed	Beginning 1	Developing 2 - CORE 2000	Proficient 3	Exemplary 4
5A.1 Context of and Purpose for Writing	Level of understanding of context, audience (perceptions, expectations, assumptions), and purpose relevant to the writing task(s) and adjustment of writing to address those considerations	Demonstrates awareness of context, audience, purpose, or task.	Demonstrates minimal attention to context, audience, purpose and task.	Demonstrates adequate consideration that aligns work to considerations of audience, context, purpose, and task.	Demonstrates a thorough understanding that focuses all elements of the work.
5A.2 Organization and Conventions	Clear and consistent organizational pattern and structuring elements including introduction, thesis and main points, conclusion, and transitions; follows formal and informal rules of genre or disciplinary expectations about organization, content, presentation, formatting, and stylistic choices.	Develops unclear or inconsistent organizational pattern; shows little awareness of genre and disciplinary conventions.	Develops organizational pattern unevenly; follows disciplinary or task expectations at a basic level of understanding.	Develops recognizable organizational pattern that structures the whole work; uses disciplinary or task conventions consistently.	Develops organizational pattern that enhances flow and cohesiveness through the whole work; demonstrates detailed attention to and successful execution of disciplinary or task conventions.
5A.3 Content Development	Uses appropriate and relevant content to develop ideas, situate ideas in a disciplinary context, and shape the work	Demonstrates simplistic development of content in some parts of the work.	Demonstrates appropriate development of ideas and disciplinary context through most of the work.	Demonstrates compelling ideas and subject development through the whole work.	Demonstrates subject mastery.
5A.4 Sources and Evidence	Uses a variety of quality sources and acknowledges different views to support ideas appropriate for discipline and genre of writing (e.g., citation styles); may use data to support observations and draw conclusions	Demonstrates minimal support for ideas in the writing.	Demonstrates an attempt to use credible and/or relevant sources.	Demonstrates consistent use of credible, relevant sources.	Demonstrates skillful use of high-quality, credible, diverse, and relevant sources.
5A.5 Control of Syntax and Mechanics	Quality of language use to communicate meaning and control over errors	Shows some understanding of writing basics but errors distract from meaning.	Shows understanding of writing basics and conveys meaning although may have noticeable errors.	Shows competent use of writing to clearly convey meaning with few errors.	Shows skillful use of writing to communicate meaning with clarity, fluency, and virtually error-free.

April 2014

This rubric is reprinted from the Michigan Technological University Student Learning Goals website. http://www.mtu.edu/assessment/program/university-learning-goals/. Originally accessed June 1, 2015. This material was used in the assessment described in Chapter Five of this dissertations. Please see Appendix G for letter granting permission to reprint this rubric.

Appendix G

MichiganTech
Michigan Technological University

Innovation and Industry Engagement
Advanced Technology Development Complex
1400 Townsend Drive
Houghton, Michigan 49931-1295
906-487-2228 • Fax 906-487-1979

February 2, 2016

Michigan Technological University
Graduate School
1400 Townsend Drive
Houghton, MI 49931

This letter is to confirm that Michigan Technological University (Michigan Tech) asserts no ownership to the written content of Nancy Barr's dissertation, ***Extending Writing in the Disciplines (WID) to train mechanical engineering GTAS to evaluate student writing***, as provided under University Policy 3.3.5 http://www.mtu.edu/faculty-handbook/faculty/chapter3/s3-3/3.3.5.html.

Michigan Tech further grants a worldwide non-exclusive perpetual license to any written or graphical works that are presented within the dissertation that happen to be owned by the Michigan Tech and that are outside the purview Policy 3.3.5.

Please contact the Office of Innovation and Industry Engagement for any questions or concerns.

Regards,

[redacted]

David D. Reed
Vice President for Research

Cc: Nancy Barr