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Embedding Technical Writing Into Mechanical Engineering Curriculum: Tools for Immediate Feedback on Student Performance

Mary M. McCall, University of Detroit Mercy

I have taught Technical Writing and Business Communication at the university and community college level for more than 30 years. My current focus at Detroit Mercy is the Embedded Technical Writing Program for Mechanical Engineering, now in its sixth year. Other work includes reference book and fiction publishing, communication consulting with business and industry, and writing, employee training, and developing marketing strategies for non-profit and arts organizations.

Dr. Nassif E. Rayess, University of Detroit Mercy

Nassif Rayess is Professor and Chair of Mechanical Engineering at University of Detroit Mercy. He was part of the efforts to introduce entrepreneurially minded learning to the University as part of the KEEN Network and Engineering Unleashed. He is also directly involved in the curricular elements of the co-op program at the University, and teaches the professional development courses that bookends the co-op semesters. He received his Ph.D. from Wayne State University and joined Detroit Mercy in 2001.

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Background

Mechanical Engineering (ME) students at University of Detroit Mercy have traditionally fulfilled their technical writing requirement by taking a stand-alone, 15-week course, typically in the sophomore or junior year. Based on research and experiences, the faculty reached the consensus that a single exposure to technical writing was not enough to sustain student skills nor improve them. Additionally, ME added a co-op experience the summer between freshman and sophomore years, which meant that technical writing skills were critical earlier in the student's education.

In addition to the experience in the ME program, outside factors influenced the need for stronger technical communication skills. In the early 2000s, engineering professional societies reported underdeveloped writing and presentation skills in entry-level job candidates while, at the same time, stressing the time spent in a typical engineer's day on communication tasks [1, 2]. At the same time, ABET adopted new criteria for evaluating and accrediting engineering programs [3]. The criteria focused on developing "soft skills" including teamwork, ethics, and effective communication, among others. The importance of soft skills has only grown in the intervening years. Among ABET's student outcomes as listed in 2019-2020 is "an ability to apply written, oral, and graphical communication in broadly-defined technical and non-technical environments; and an ability to identify and use appropriate technical literature" [4].

Program Goals

Whatever form it took, an enhanced technical writing program would have to meet these goals:

- Support ABET's instruction to produce students proficient in technical communication skills
- Respond to employer requests for freshman co-op students more versed in business and technical writing tasks
- Teach students a portable set of writing and presentation skills
- Help students develop a process approach to writing that includes audience, purpose, context, research, and format considerations
- Encourage students to develop a self-reflective approach to writing projects with the goal of becoming more proficient writers

Embedded Technical Writing Program

In Fall 2016, the ME department began an embedded technical writing project that would give ME students sustained exposure to writing concepts and practice. From a single class in Fall 2016 (Basic CAD, taken in first semester of Freshman year), the project has grown to encompass four additional classes, which are discussed later and span first- through third-year courses. In addition, technical writing instructors have been involved in coaching Capstone students in their

fourth year. All five embedded classes are co-taught by engineering and technical writing instructors.

In 2021, the second cohort of four-years exposed to the four-year technical writing program are graduating, which suggests it is time to formally evaluate the effectiveness of the program. This paper focuses on the assessment tools built into the program to provide immediate feedback to students. A follow-up paper will capture the longitudinal study that measures writing improvement in ME students.

Research

Process approach to writing – In response to feedback from employers and alumni themselves, many technical and business writing programs have adopted a process approach to writing believing incremental drafting is best suited to produce high-quality, usable documents for the workplace. A typical approach might include drafting, peer reviews, instructor feedback via a conference, a visit to the college writing center, and rewriting [5]. In addition to facilitating workplace writing, a process approach has been found beneficial in preparing students for professional practice [6].

Embedded writing programs – Some colleges and universities have formalized the process approach by embedding writing instruction directly into content classes. These courses may focus on a problem-based learning environment, where technical writing supports an engineering project [7]. Identifying "threshold concepts" and linking them to specific courses over multi-year instruction is another approach [8].

Whatever the structure, it is interesting to note that students have identified resources as well as drafting as major resources that help them become better writers. In a recent study, templates, the web, and "coworkers as peer editors" were cited [9].

Writing in workplace genres takes a different approach than much of the academic writing taught in college in that workplace writing adds problem solving to rhetorical analysis. Thus, the goal must be to teach students how to use the workplace formats to solve problems versus simply producing a document in an acceptable format [10]. In the "real world," documents either accomplish a goal or they do not [11]. Students must see an immediate practical use for the writing they do in engineering classes.

Immediacy of feedback – Among the tools most often cited in studies of student writing are those that provide immediate feedback. These include instructor comments and conferences, peer reviews, templates, user testing, online evaluations, and opportunities for reflection.

Instructor comments and conferences are a proven method for interacting with students about their writing. In one study, participants felt instructors could address the "big picture," while peers offered advice about format [6]. Another researcher found that instructor comments helped students prioritize the focus of a subsequent draft (5). The same study cited peer reviews as emphasizing the role readers play in the writing process (5).

Another popular tool among writers, students and professionals alike, is the use of templates. These tools save time and can provide an entry into the document creation process, thus reducing a "potentially crippling writing phobia" [12]. Templates abound in the workplace, from resumes to letters, memos and presentations. Some writers create their own templates, "reverse engineering" from other successful documents [13]. Author guidelines are the template by which papers like this are written [14].

Usability or user testing is another tool for providing immediate feedback. A "think-aloud" protocol allows a reviewer to interact with the text and the author simultaneously [15]. Having students write instructions based on their real-life jobs (grocery, retail, food service) and having fellow students try to use them is another form of user testing [15].

Online rubrics for grading presentations marries the need for immediate evaluation with the students' love of technology. Popular apps like Google Surveys allow audience members to rate a presentation real-time against established criteria. With PeerPresents, a team of U.S. academics has created a platform for in-class peer review [16].

Instruction, practice and reflection are the three pillars of effective teaching. Building in time for students to think about what they have learned is critical to integrating concepts and applying them in future classes and professions. Another outcome of reflection is that students begin to take charge of their own learning [17]. This transferable skill can translate into the workplace as an appreciation of continuing education, another ABET value.

The Embedded Technical Writing Program at University of Detroit Mercy implemented these and other assessment tools, knowing that immediate feedback would be a foundation for skill-building in writing, review and revision. Following are examples of pieces developed to support the program. Many of the forms and templates shown are available at the Technical Writing website developed to support the program [18].

Basic CAD (Year 1, First Semester)

In their first Engineering class in college, students learn about the value of technical writing and the communication tasks they will do daily in the workplace (See Figure 1). This gives students a context for the writing instruction they will receive over the next four years.

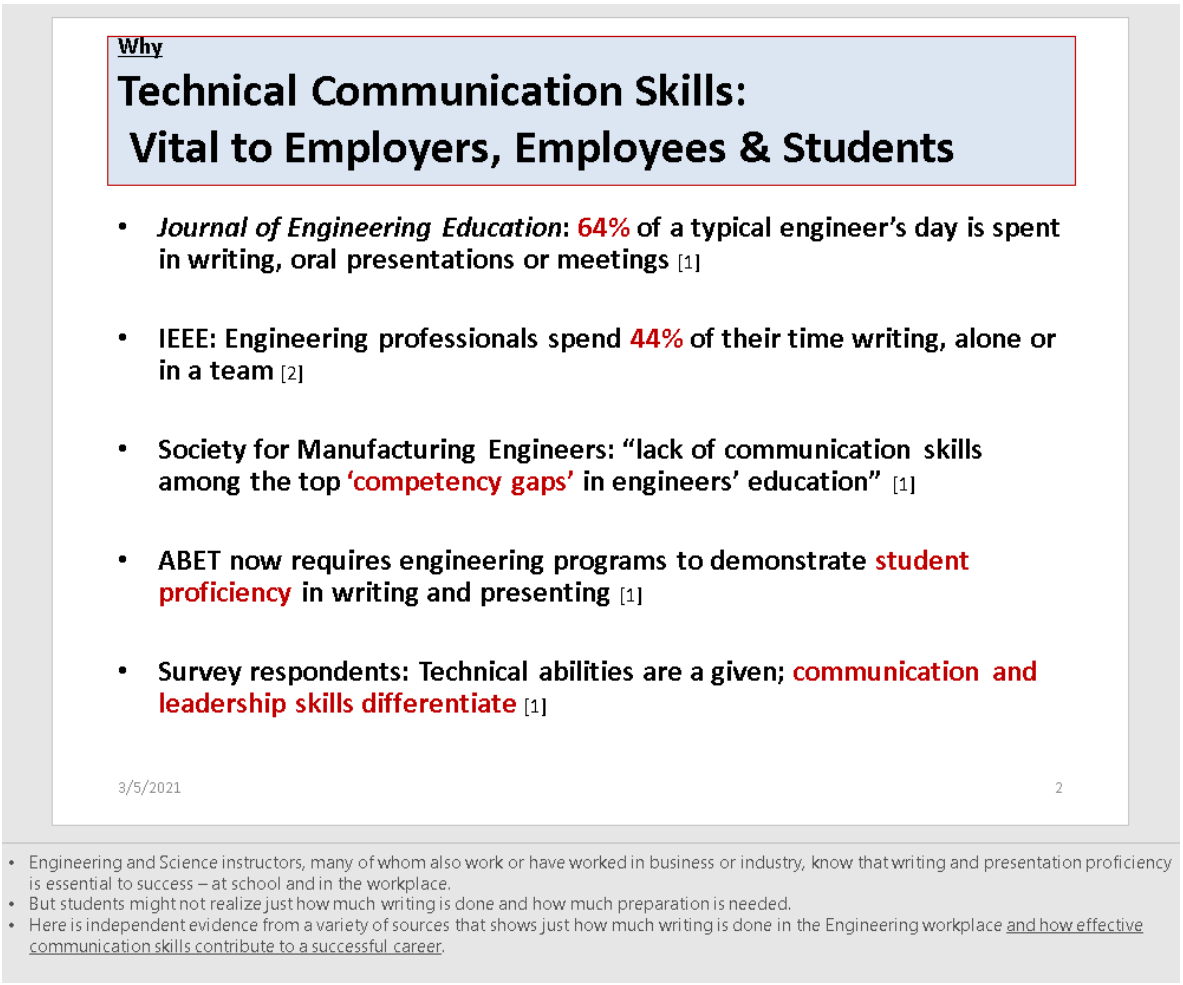


Figure 1. Transparency: Students know why they are being taught technical writing skills.

From day one, they learn about audience, purpose and context, the standard rhetorical approach to writing. After learning a basic communication model (executive, expert, technician and general audiences), their first assignment is a chance to apply audience analysis to their classmates (see Figure 2).

Writing Assignment #1: Audience Analysis of Students in ENGR 1020

Overview: For this assignment, you will practice analyzing an audience by writing about the students in this course. Using the model outlined in class and your own research, you will submit an evidence-based description of this audience, along with ideas on writing tools for reaching them and their preferred formats.

Pay-back: This summer, you will be doing your first Engineering Co-op. You will meet and write for many different kinds of employees, including other Co-op students, entry-level engineers, and your supervisor. When you have completed your Audience Analysis, you will have begun to apply a basic writing strategy useful for any engineering project. Your projects, both school and work, will have a better chance of succeeding if you know and can meet the needs of the target audience.

Instructions: Audience Analysis of Students in ENGR 1020 (Points: 2 points)

Description: In the workplace, you will be producing engineering drawings for colleagues. For this assignment, your fellow students in ENGR 1020 will be representative of the co-op and entry-level colleagues at your co-op job. Use a formal tone and a two-part title (ex., Type of Document: Topic of Document). Since effective writing uses an Introduction, Body, Conclusion format, arrange your analysis into three parts. Use subheads to indicate the three different parts.

Introduction: Using the audience analysis model from class, determine which of the four basic audiences your classmates represent. You must do more than simply say: "Students in ENGR 1020 are typical of the XXX type of audience" since this is an unsupported claim. Take this assertion a step further and include 3-4 reasons why you are making this statement: "Students in ENGR 1020 are typical of the XXX type of audience because they are A, B, and C." This gives you a thesis statement to work from and forms the Introduction for your analysis.

Discussion (Body): Now you need to offer data to support your A, B, and C claims. Create the Body of your analysis by using examples of what you see, statements made by your classmates or instructor when you interview them, material from the class lecture and the Blackboard site, and sources you find on your own. Remember, personal opinions are not acceptable evidence in the workplace. Do not use unsupported claims that start with "I think…", "I feel…", or "I believe…" Instead, make statements that are supported by evidence. Also suggest writing tools and formats you will use to reach this target audience.

Conclusion: Reinforce your thesis statement and comment on the value of audience analysis in the workplace.

References: For this assignment, use MLA style for in-text citations and to produce a Works Cited list at the end of your analysis. You will include two secondary* and one primary** research sources. *Secondary research is already-published data, such as books, journal articles, and presentations. **Primary research is research you do yourself and includes interviews, site visits and observations.

NOTE: Be sure to use Spell Check and proofread your work before submitting it.

This assignment sheet, the peer review forms, and the grading rubric are available on Blackboard.

Figure 2. ENGR 1020 – Writing Assignment 1 – Instructions.

Students receive instructor feedback on their rough draft, then do a peer review with two classmates (see Figure 3).

Peer Editing Worksheet: Audience Analysis – Students in ENGR 1020

Names of Students Who Read Your Assignment:

_____ _____

Remember: You must submit 2 completed Peer Review forms on the due date.

Peer Editing: Approach

The goal of a peer review is to work together to produce a more effective work document. Since the peer review usually takes place within an ongoing relationship, you need to preserve and strengthen the working relationship. Remember to respect the author's feelings and sense of ownership.

- Put your pencil down and read the entire document; then edit.
- Don't use a red pen.
- Try for a face-to-face meeting to discuss your comments/questions.
- Use the peer editing worksheet or the assignment rubric to guide the conversation.
- Begin with a positive statement, if possible (ex., The layout worked really well because…).
- Use "I" statements to offer your observations (ex., I noticed, I wondered, I believe, I did not understand, I could not follow…).
- Offer examples from the author's text to illustrate your points.
- Do not feel obliged to offer solutions (the author can usually solve his/her own problems).

Assignment has		
Two-part title	Yes	No
Subheads	Yes	No
Formal tone	Yes	No
Works Cited in proper MLA format	Yes	No
Header/Footer with a page number	Yes	No
Been edited and proofread	Yes	No
Introduction		
Type of audience is named	Yes	No
Examples are given to back this statement	Yes	No
Discussion (Body)		
Statements (claims) are backed by evidence		
(2 secondary, 1 primary)	Yes	No
Three required sources are used	Yes	No
Conclusion		
Writer circles back to the thesis statement	Yes	No
Writer comments on value of doing audience analysis	Yes	No

ENGR 1020 – Fall 2020 – McCall Orig. 11/2016, Rev. 1/2017, 8/2017, 12/2019

Figure 3. ENGR 1020 – Writing Assignment 1 - Peer Review Form.

With feedback from three sources, they are prepared to revise their first audience analysis and submit it for grading (see Figure 4). They are learning process writing and know what to expect in future assignments.

ENGR 1020 **Grading Rubric: Writing Assignment #1** **Fall 2020**

Grading Rubric: Audience Analysis of Students in ENGR 1020

Student Name: _____ Course Number: ENGR 1020/Writing Assignment #1

Instructor Name: _____McCall_____ Date: _____

	Metric	Level of achievement				
		5	4	3	2	1
(Writing 2 pts.)	Professionalism: Assignment has two-part title (Type of Document: Topic of Document), subheads, header/footer, formal tone	All required elements are included	Most required elements are included	Some required elements are included	Few required elements are included	No required elements are present
	Introduction names a specific audience with examples given	All required elements are included	Most required elements are included	Some required elements are included	Few required elements are included	No required elements are present
	Discussion (Body) offers details with claims and examples supported by cited evidence (no personal opinions are present)	All required elements are included	Most required elements are included	Some required elements are included	Few required elements are included	No required elements are present
	Conclusion reinforces the type of audience identified and sums up the value of audience analysis as a workplace tool	All required elements are included	Most required elements are included	Some required elements are included	Few required elements are included	No required elements are not present
	Evidence is used in text as needed to support claims	All claims are supported by evidence	Most claims are supported by evidence	Some claims are supported by evidence	Few claims are supported by evidence	No claims are supported by evidence (document is an opinion piece and lacks credibility)
	Evidence is cited in text using MLA style	All evidence is cited correctly	Most evidence is cited correctly	Some evidence is cited correctly	Little evidence is cited correctly	No evidence is cited correctly
	Works Cited is offered in MLA format at the end of the document	All sources are listed in MLA format	Most sources are listed in MLA format	Some sources are listed in MLA format	Few sources are listed in MLA format	No sources are listed in MLA format
	Grammar, spelling and punctuation are correct	Grammar is excellent, and spelling and punctuation are correct	Some minor grammar, spelling and/or punctuation errors are present	Grammar, spelling or punctuation errors interrupt the flow of ideas	Poor grammar, spelling or punctuation make the document difficult to read	Grammar, spelling and/or punctuation errors render the document unreadable
	Assignment is complete and submitted on time	Yes				No

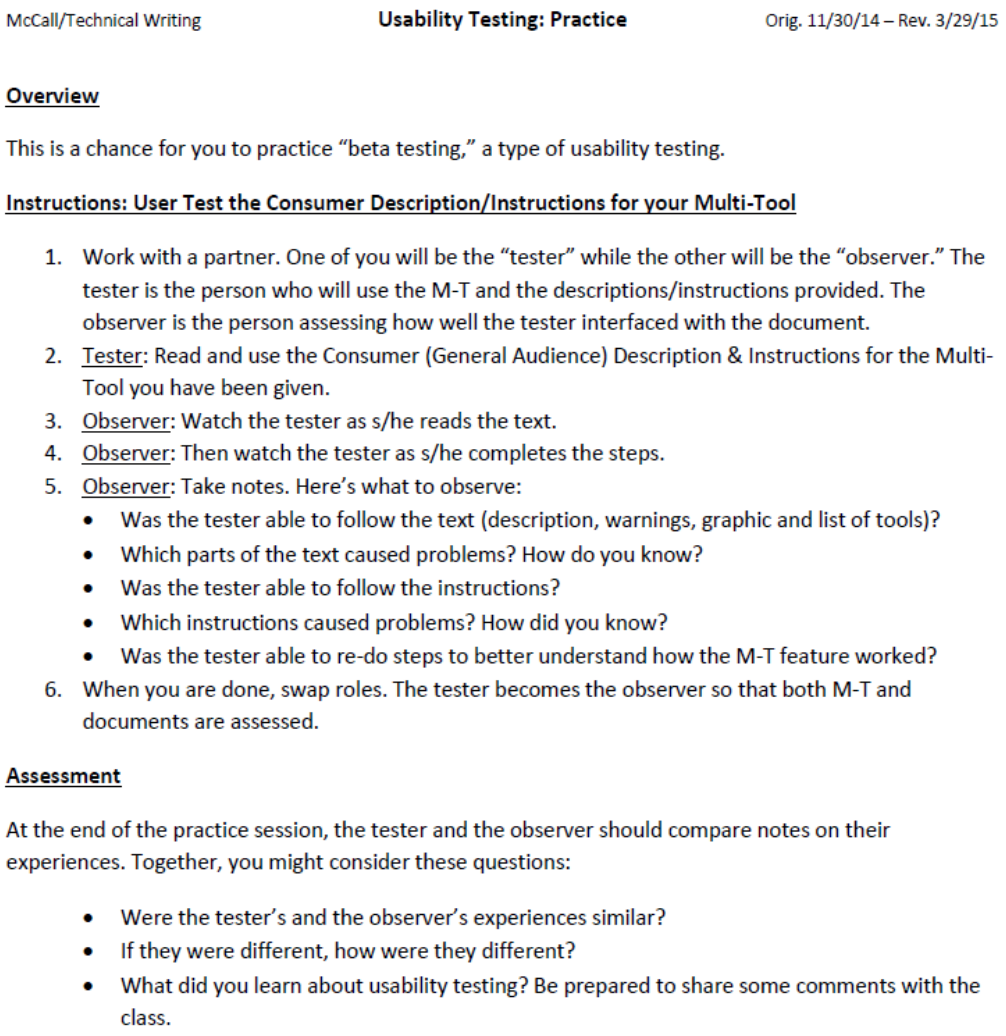
Orig. 8/2017, Rev. 12/2019

Figure 4. ENGR 1020 – Writing Assignment 1 - Grading Rubric.

The other writing project in Basic CAD has students create support documents for a multi-tool they design using CAD software. They learn to write for an executive audience in a memo to the

immediate supervisor where they include enough of the right kind of details to secure approval for their project. After doing an audience analysis of "the consumer," they generate two sets of instructions, one for a beginner and one for a more technically proficient user. Students begin to see the differences in how documents are designed based on audience and purpose.

A rudimentary form of usability testing helps students see the effectiveness of their multi-tool instructions. They exchange rough drafts with classmates and work together to identify and amend areas that confuse the reader (see Figure 5). This feedback happens in the classroom setting and is immediate and useful.



McCall/Technical Writing **Usability Testing: Practice** Orig. 11/30/14 – Rev. 3/29/15

Overview

This is a chance for you to practice "beta testing," a type of usability testing.

Instructions: User Test the Consumer Description/Instructions for your Multi-Tool

1. Work with a partner. One of you will be the "tester" while the other will be the "observer." The tester is the person who will use the M-T and the descriptions/instructions provided. The observer is the person assessing how well the tester interfaced with the document.
2. Tester: Read and use the Consumer (General Audience) Description & Instructions for the Multi-Tool you have been given.
3. Observer: Watch the tester as s/he reads the text.
4. Observer: Then watch the tester as s/he completes the steps.
5. Observer: Take notes. Here's what to observe:
   - Was the tester able to follow the text (description, warnings, graphic and list of tools)?
   - Which parts of the text caused problems? How do you know?
   - Was the tester able to follow the instructions?
   - Which instructions caused problems? How did you know?
   - Was the tester able to re-do steps to better understand how the M-T feature worked?
6. When you are done, swap roles. The tester becomes the observer so that both M-T and documents are assessed.

Assessment

At the end of the practice session, the tester and the observer should compare notes on their experiences. Together, you might consider these questions:

- Were the tester's and the observer's experiences similar?
- If they were different, how were they different?
- What did you learn about usability testing? Be prepared to share some comments with the class.

Figure 5. ENGR 1020 – Usability Testing Practice - Instructions.

By the end of their first semester, students have begun to understand the value of audience analysis and how it supports their work, along with learning the purpose of memos and professional tone. They take these transferable skills with them to their next class with a technical writing component.

Fundamentals of Engineering Design (Year 1, Second Semester)

In Fundamentals of Engineering Design, students work together to research, develop and present a technology to a potential investor audience. This class starts with a research assignment, a memo to their immediate supervisor describing the potential value of Internet of Things to their product. This assignment builds on research skills and teaches how to summarize and present information for executive decision making. Students receive feedback from the engineering and the technical writing instructors.

Students learn another audience model, inter-generational communication, through team presentations in class. In addition to learning communication tips themselves, they strengthen their research, summary, and presentation skills. In the interest of immediate feedback, students are evaluated real-time using a Google Survey tool.

The same Google Survey tool is used for the other presentations done in class. Figure 6 shows a slide from an individual value proposition slide, the assignment that launches the investor appeal.

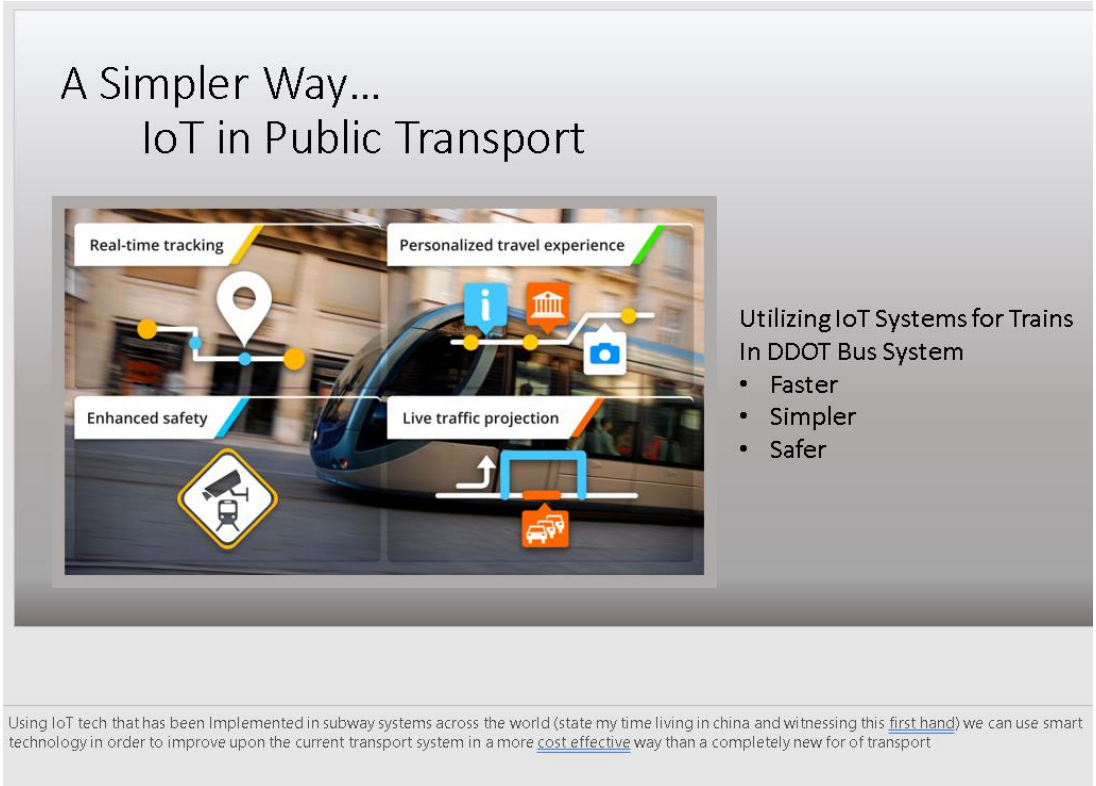
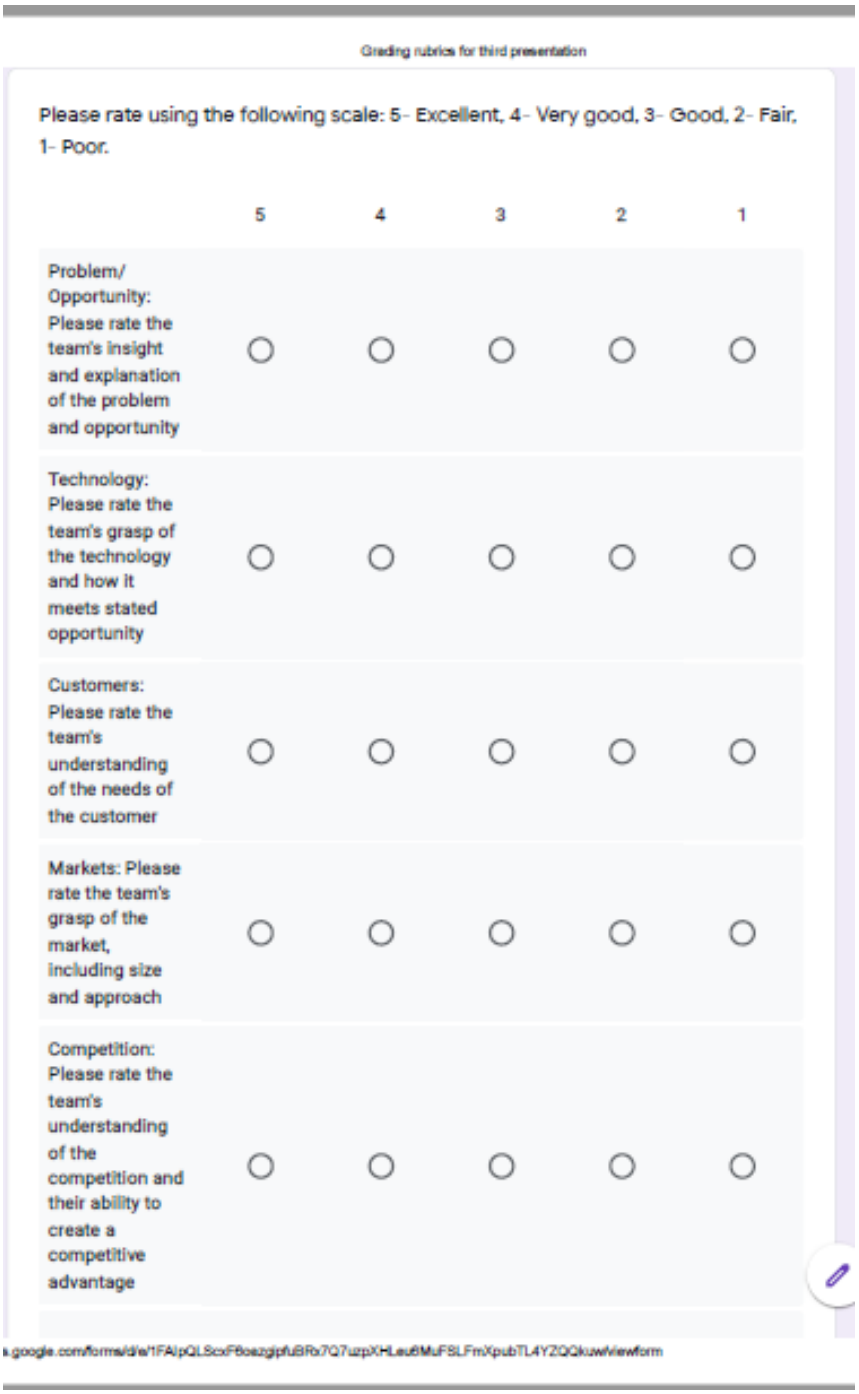


Figure 6. ENGR 1080 – Individual Value Proposition – Student Sample.

Individual value propositions are blended into team value propositions, and teams present on customer discovery (primary and secondary research), financials, a technology roadmap, a venture plan, and final presentation comprising all their previous work. This approach underscores the process approach as students build the final presentation throughout the semester. Using a process approach allows them to refine their final presentation and helps them build confidence in their presentation skills.

All presentations are evaluated via the Google Survey tool, which offers immediate feedback (see Figure 7). Students receive numerical feedback as well as comments from classmates and instructors. Students also upload their files so the writing instructor can coach students on global issues such as audience appeals, detail, and theme.



Grading rubrics for third presentation

Please rate using the following scale: 5- Excellent, 4- Very good, 3- Good, 2- Fair, 1- Poor.

	5	4	3	2	1
Problem/ Opportunity: Please rate the team's insight and explanation of the problem and opportunity	○	○	○	○	○
Technology: Please rate the team's grasp of the technology and how it meets stated opportunity	○	○	○	○	○
Customers: Please rate the team's understanding of the needs of the customer	○	○	○	○	○
Markets: Please rate the team's grasp of the market, including size and approach	○	○	○	○	○
Competition: Please rate the team's understanding of the competition and their ability to create a competitive advantage	○	○	○	○	○

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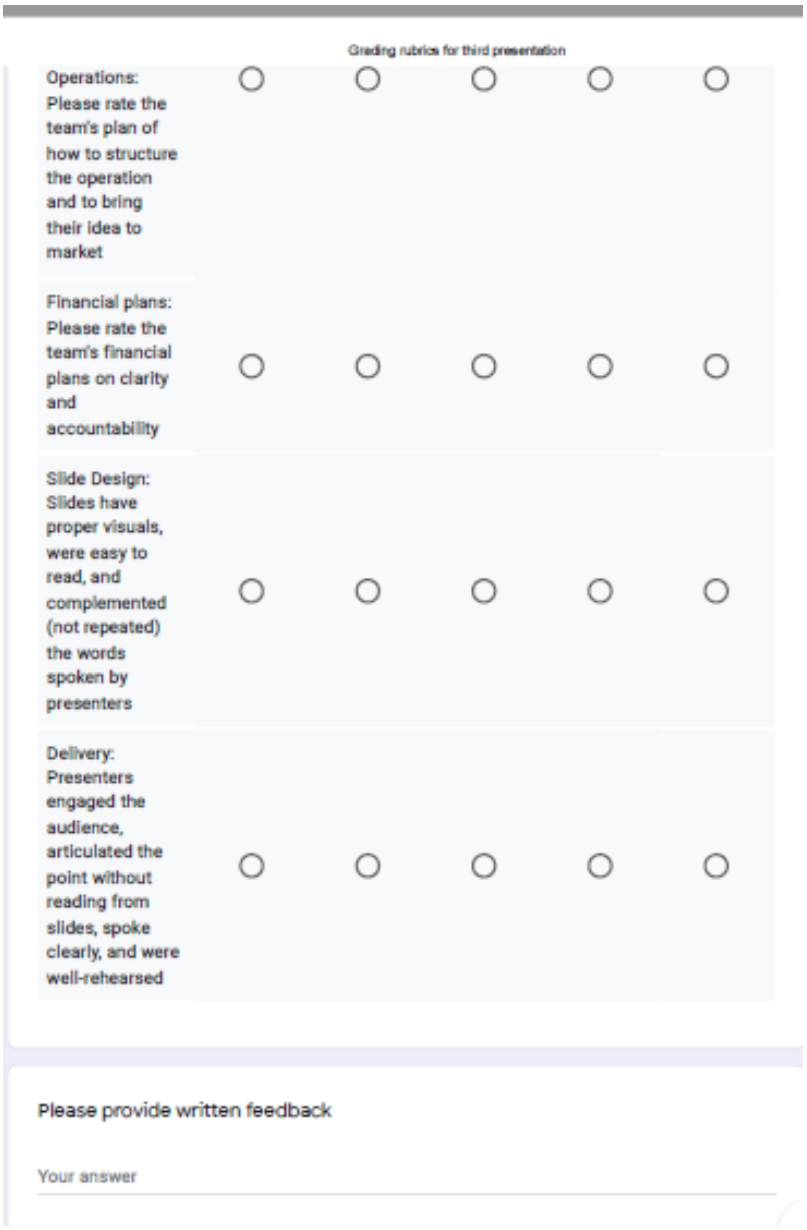


Figure 7. ENGR 1080 – Google Grading Rubric – Investor Presentation.

By the end of the semester, students have strengthened audience, research, teamwork and presentation skills. They have also polished their feedback skills and applied a process approach to an extended writing project, this time a presentation. They are better prepared to meet the expectations of employers in their first coop experience in the summer between their first and second year.

Intermediate CAD (Year 2, First Semester)

When they return to the classroom as second-years, students have a better sense of how companies work, reporting relationships, professional demeanor, and the types of documents produced. This is a good introduction to design report writing, which is the main writing focus in Intermediate CAD. Once again students produce a product using CAD software. The audience for their work, however, is not a consumer but an engineering supervisor with technical knowledge and decision-making authority. The student's job is to produce a report that is technically sound and professional in appearance so as to win a favorable decision to move their project forward.

Students use a design report template to capture their design story. The template outlines the sections to include and offers instructions about content, tone, and graphics (see Figure 8). The idea is to save time and allow students to focus on the content portion of the writing process.

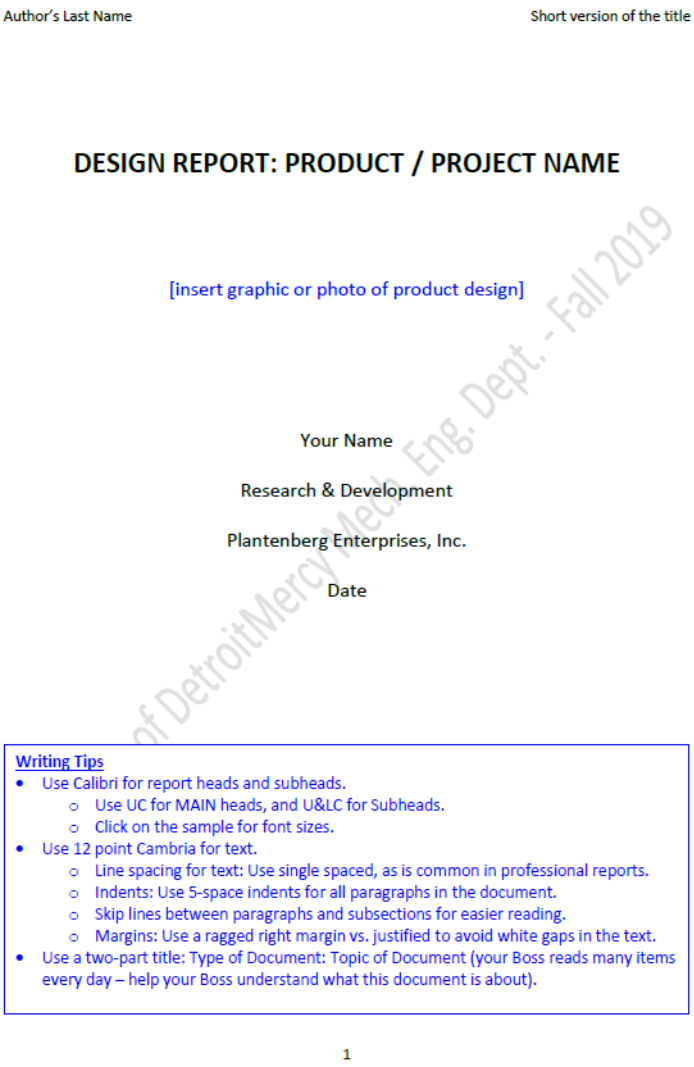


Figure 8. ENGR 1021, MENG 4920 – Design Report Template [18].

Students use the same process writing approach, producing a rough draft for instructor comments, doing a peer review, and then submitting a final document. At the end of the process, the instructors do a design report review, pulling sections from student reports to underscore how the work meets the needs and preferences of the technical reader (their engineering instructor).

Students continue to refine teamwork skills and add to their writing toolbox through an in-class exercise on graphics. They are given a situation, an audience, and raw data and asked to create and then present a graphic that will accomplish the purpose (see Figure 9).

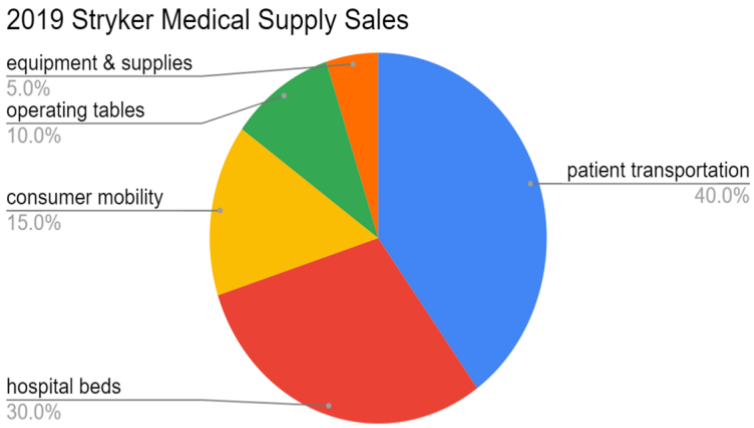


Figure 9. ENGR 1021 – Graphics Presentations in Teams – In-Class Activity

Through discussion they receive immediate feedback on their work. By submitting a file, they receive writing instructor coaching.

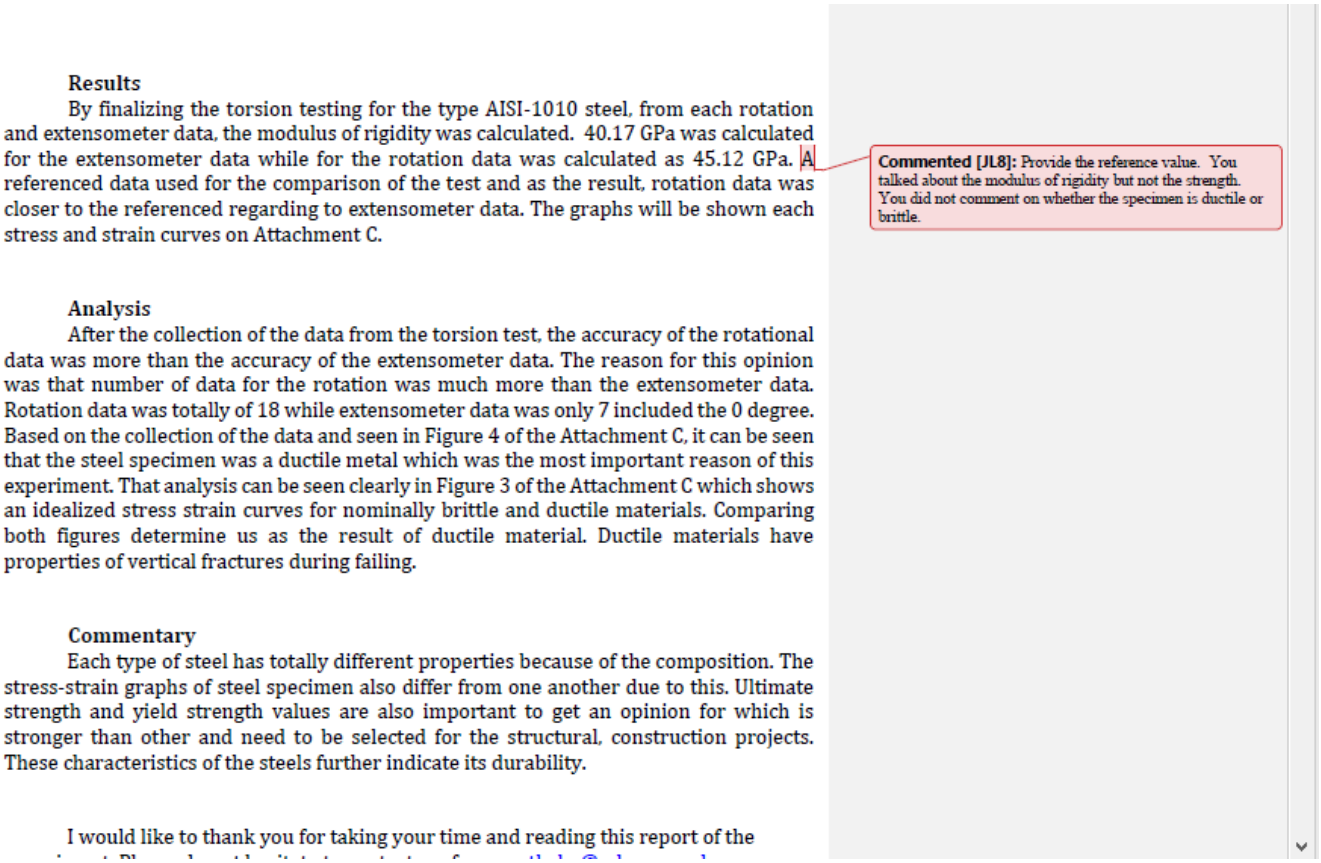
By the end of the course, students have more experience in process writing and sustaining longer-term projects and have polished professional and teamwork skills.

Mechanics of Materials Lab (Year 2, First or Second Semester)

In their next class with a technical writing component, students learn more about producing reports that support work in a laboratory setting. Each class period begins with a brief lecture about writing and then moves into lab work and data analysis.

Using formal report and memo templates [18], students produce individual and team reports, which give them a chance to add to writing and teamwork skills. In group reports, roles are rotated so each student has experience in writing different sections and acting as the group editor.

Figure 10 illustrates the type of comments they receive from the engineering instructor.



Results

By finalizing the torsion testing for the type AISI-1010 steel, from each rotation and extensometer data, the modulus of rigidity was calculated. 40.17 GPa was calculated for the extensometer data while for the rotation data was calculated as 45.12 GPa. A referenced data used for the comparison of the test and as the result, rotation data was closer to the referenced regarding to extensometer data. The graphs will be shown each stress and strain curves on Attachment C.

Commented [JL8]: Provide the reference value. You talked about the modulus of rigidity but not the strength. You did not comment on whether the specimen is ductile or brittle.

Analysis

After the collection of the data from the torsion test, the accuracy of the rotational data was more than the accuracy of the extensometer data. The reason for this opinion was that number of data for the rotation was much more than the extensometer data. Rotation data was totally of 18 while extensometer data was only 7 included the 0 degree. Based on the collection of the data and seen in Figure 4 of the Attachment C, it can be seen that the steel specimen was a ductile metal which was the most important reason of this experiment. That analysis can be seen clearly in Figure 3 of the Attachment C which shows an idealized stress strain curves for nominally brittle and ductile materials. Comparing both figures determine us as the result of ductile material. Ductile materials have properties of vertical fractures during failing.

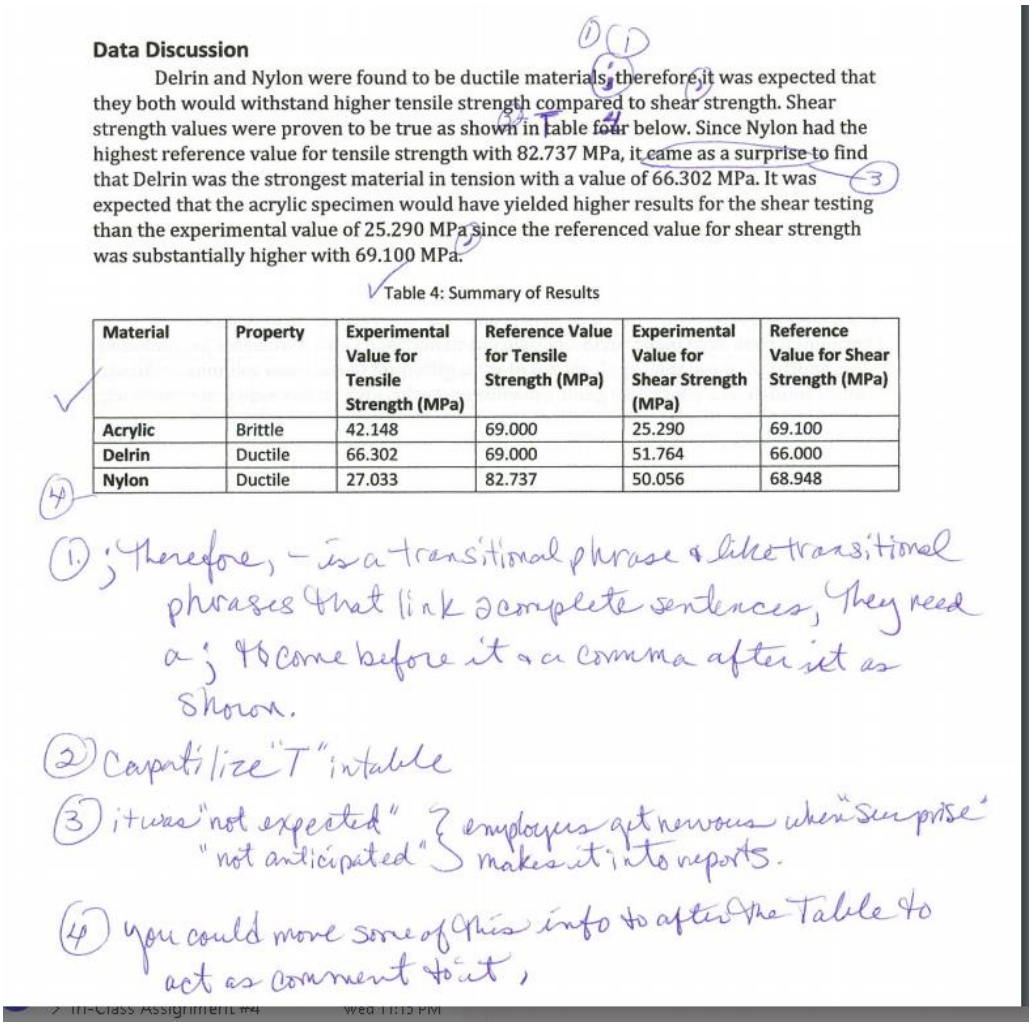
Commentary

Each type of steel has totally different properties because of the composition. The stress-strain graphs of steel specimen also differ from one another due to this. Ultimate strength and yield strength values are also important to get an opinion for which is stronger than other and need to be selected for the structural, construction projects. These characteristics of the steels further indicate its durability.

I would like to thank you for taking your time and reading this report of the

Figure 10. ENGR 3270 – Laboratory Report – Engineering Instructor Comments.

Figure 11 illustrates the type of feedback given by the technical writing instructor. Students also practice peer review skills working in their teams. By the time they submit a final report, they have received feedback from multiple sources and produced at least two drafts of each report.



Data Discussion

Delrin and Nylon were found to be ductile materials, therefore it was expected that they both would withstand higher tensile strength compared to shear strength. Shear strength values were proven to be true as shown in table four below. Since Nylon had the highest reference value for tensile strength with 82.737 MPa, it came as a surprise to find that Delrin was the strongest material in tension with a value of 66.302 MPa. It was expected that the acrylic specimen would have yielded higher results for the shear testing than the experimental value of 25.290 MPa since the referenced value for shear strength was substantially higher with 69.100 MPa.

Table 4: Summary of Results

Material	Property	Experimental Value for Tensile Strength (MPa)	Reference Value for Tensile Strength (MPa)	Experimental Value for Shear Strength (MPa)	Reference Value for Shear Strength (MPa)
Acrylic	Brittle	42.148	69.000	25.290	69.100
Delrin	Ductile	66.302	69.000	51.764	66.000
Nylon	Ductile	27.033	82.737	50.056	68.948

(1) ; Therefore, – is a transitional phrase & like transitional phrases that link complete sentences, they need a ; to come before it & a comma after it as shown.

(2) Capitalize "T" in table

(3) it was "not expected" } employees get nervous when "surprise" "not anticipated" } makes it into reports.

(4) You could move some of this info to after the Table to act as comment to it,

Figure 11. ENGR 3270 – Laboratory Report – Technical Writing Instructor Comments.

By the end of the class, students have learned to edit team reports for a single voice and to offer the kinds of details that a technically proficient supervisor would expect.

Computer Aided Engineering (Year 3, Second Semester)

The third-level CAD class works much the same way as the lab report class. Sessions start with a brief writing lecture and students complete a worksheet about key ideas to help in retention. Students then use CAD software to create single and multi-part products, which they write about. The first report is a Wrench Design Report that describes a redesign of an existing product. Students broaden their research skills to include wrench design (patents), materials, and manufacturing.

Students use the same design report template [18] and the same writing process to produce rough drafts for instructor and peer reviews. Built into the process is a design review by the engineering instructor, so students are receiving real-time writing and technical feedback on their work.

Figure 12 shows a checklist to help students track whether they are including all the needed sections in their report. Tools like this give students immediate feedback about where they are in their writing process.

MENG 4920 Writing Worksheet 6 Writing the Rough Draft

Instructions

This Checklist gives you a chance to see if you've assembled all the data you need to write the Rough Draft of the Heat Sink Design Report. Upload your completed Checklist to Blackboard.

Suggestion: Keep a copy of this checklist and use it in writing the Design Report.

Due: 4/8/2021

Post to Blackboard.

Checklist	Yes	No
1. Have I re-read the assignment packet?		
2. Am I clear on the deadlines for rough drafts, peer reviews and final drafts?		
3. Is my Research handy? (ex., patents, material options, costs, etc.)		
4. Do I have my citations ready for ASME formatting?		
5. Have I pulled key data from my Engineering Worksheets? (ex., numbers for weight, strength, percent of improvement, etc.)?		
6. Have I pulled SolidWorks images for each design iteration and given each a Figure number, title and caption?		
7. Are my FEA test results available?		
8. Have I entered my FEA test results in a Table with a number, title and caption?		
9. Have I formatted my FEA images for import into the Report?		
10. Have I reviewed the Design Report template?		
11. Have I reviewed instructor comments on rough drafts and previous Design Reports?		
12. Have I developed a personalized Proofreading list so I read for the mistakes I typically make?		

Figure 12. MENG 4920 – Writing the Rough Draft – Checklist.

Later in the semester, students write a design report about two heat sink designs, each using a different material. They are building analytical skills and using research that help them present pros and cons for their technical proficient reader to make a decision.

When the final drafts are submitted, students are graded against a rubric that is made available when the assignment is announced (see Figure 13). As students mature in their understanding of feedback, they begin to use the rubric to guide their peer reviews versus needing a separate form.

University of Detroit Mercy College of Engineering & Science Winter 2021

Name: _____ Design Report: Wrench Redesign - FD Grad / Undergrad

MENG 4920 Individual Design Report: Grading Rubric

Technical Content and Writing	5	4	3	2	1
Materials Used Available materials are clearly described.					
Materials Used - Sources Sources for materials are cited in-text and in References.					
Material Choice - Factors Reader has a clear idea of why specific material was selected.					
Material Choice - Sources Sources for materials are cited in-text and in References.					
Manufacturing - Process Description (grad students) Manufacturing processes are described and rationale for selected method are provided.					
Manufacturing - Sources (grad students) Sources for process are cited in-text and in References.					
Design Methodology Design problem is clear, the approach is described, and design iterations are discussed.					
Final Design The Final Design meets specifications and criteria.					
FEA Results Test results are discussed, compared, and captured in a table(s) in the report body.					
Detailed Drawings SolidWorks sketches are discussed, and have title, number, and caption.					
Report Reader Enough data is provided to persuade an SME reader that the design choices are viable and based on secondary and primary research.					
Report Format Approved UDM template is used correctly and required sections are in order.					
Research / Evidence All claims are supported by evidence using AMSE in-text citation format.					
Graphics (Figures and Tables) All graphics are introduced in text prior to appearance and include a number, title, and caption.					
References All references are cited in ASME format at the end of the report.					
Appendix (ces) Material in Appendices is referred to in the report, and each is given a title.					
Professionalism Report has been edited and proofread, uses formal tone appropriate to the workplace, text is clear and concise, and transitions are used to bridge sections.					

Levels of Achievement: 5 = Project is complete and professional. Supervisor would accept the project files and report. 4 = Supervisor would have questions about the project and/or report. 3 = Supervisor would ask for meeting to clarify issues associated with the project and/or report. 2 = Supervisor would require portions of the project and/or report to be redone. 1 = Supervisor would reject the project and/or report.

Orig. 1/2019, Rev. 1/2020, 2/2020, 1/2021

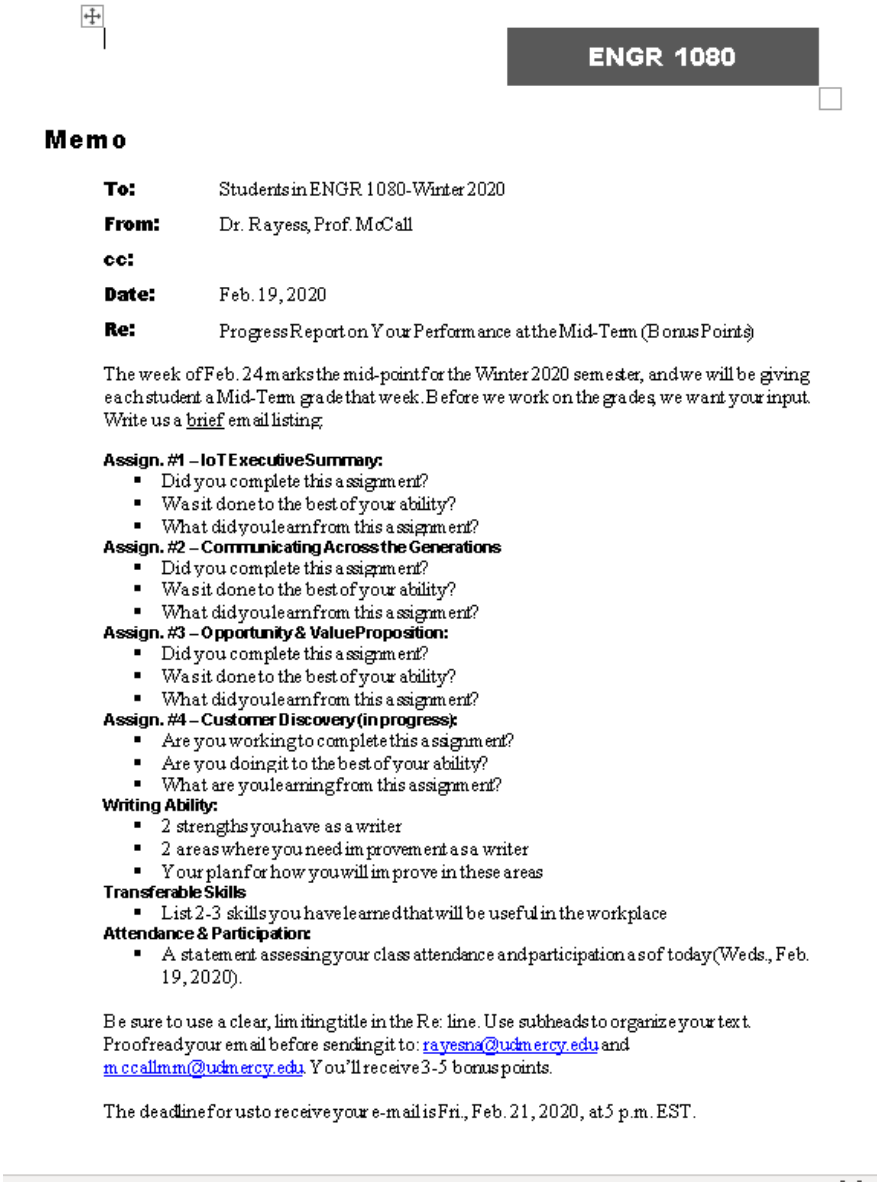
1

Figure 13. MENG 4920 – Report Grading Rubric.

Reflection

Instruction, practice, feedback, assignment, grading, reflection – these are the steps to learning and integrating new information and skills. Immediate feedback helps students produce acceptable final drafts for submission. Reflection helps them internalize new ideas and are the basis for the portable communication skill set that employers value. All embedded technical writing courses have multiple chances for students to reflect.

A Mid-Term Self-Assessment gives students a chance to evaluate their writing skills and commitment to the class (see Figure 14). As it is written in a memo format, it offers another chance to practice memo-writing skills.



ENGR 1080

Memo

To: Students in ENGR 1080-Winter 2020

From: Dr. Rayess, Prof. McCall

cc:

Date: Feb. 19, 2020

Re: Progress Report on Your Performance at the Mid-Term (Bonus Points)

The week of Feb. 24 marks the mid-point for the Winter 2020 semester, and we will be giving each student a Mid-Term grade that week. Before we work on the grades, we want your input. Write us a brief email listing:

Assign. #1 – IoT Executive Summary:
- Did you complete this assignment?
- Was it done to the best of your ability?
- What did you learn from this assignment?

Assign. #2 – Communicating Across the Generations
- Did you complete this assignment?
- Was it done to the best of your ability?
- What did you learn from this assignment?

Assign. #3 – Opportunity & Value Proposition:
- Did you complete this assignment?
- Was it done to the best of your ability?
- What did you learn from this assignment?

Assign. #4 – Customer Discovery (in progress):
- Are you working to complete this assignment?
- Are you doing it to the best of your ability?
- What are you learning from this assignment?

Writing Ability:
- 2 strengths you have as a writer
- 2 areas where you need improvement as a writer
- Your plan for how you will improve in these areas

Transferable Skills
- List 2-3 skills you have learned that will be useful in the workplace

Attendance & Participation:
- A statement assessing your class attendance and participation as of today (Weds., Feb. 19, 2020).

Be sure to use a clear, limiting title in the Re: line. Use subheads to organize your text. Proofread your email before sending it to: rayessn@udmercy.edu and mccallmm@udmercy.edu. You'll receive 3-5 bonus points.

The deadline for us to receive your e-mail is Fri., Feb. 21, 2020, at 5 p.m. EST.

Figure 14. ENGR 1080 – Mid-Term Self-Assessment – Chance for Reflection on Performance and Commitment to the Class.

Immediate feedback on their work is motivational for students. In some cases, the feedback is self-generated. Checklists like the one show in Figure 15 prompt students to develop the habit of self-reflection. This work habit allows them to learn from each project and carry forward the lessons learned into their next project.

MENG 4920 Writing Worksheet 5 Design Report Review

Instructions

As you watch the Design Report review in class, take note of what you need to work on. You might also want to refer to the comments on your Design Report: Wrench as you complete this worksheet. Upload your completed Checklist to Blackboard.

Suggestion: Keep a copy of this checklist and use it in writing your next Design Report.

Due: 3/4/2021.

Post to Blackboard.

Checklist	What Do I Need to Work on?
1. I need to follow the Design Report Template more closely.	
2. My Abstract needs to include more numbers and percentages, not just words.	
3. My Research needs to be cited in text [#] as I use the sources.	
4. I need to write a clear Design Challenge/Problem.	
5. I need to include Specifications and Criteria and an in-text citation.	
6. I need to give each design iteration a name (ex., Design1, Design2, etc.).	
7. I need to clearly explain the purpose for each design iteration (ex., weight reduction, increased strength).	
8. I need to make sure I mention Figures and Tables in the text before I show them.	
9. I need to use a transition at the end of each design iteration that bridges to the next section.	
10. My Test results need to be captured in a Table.	
11. My Conclusion must include key numbers for the final design (ex., strength, weight, percent of improvement, cost, etc.).	
12. I can include extra interesting or helpful information and images in an Appendix.	
13. My text must be written in third person and use formal language.	
14. I have read and used the comments from my Rough Draft.	
15. My Report must be proofread by me and a back-up reader, as well as Spell Checked.	

Figure 15. MENG 4920 – Design Report Review – Reflection.

In several classes, students see a “best in class” presentation that highlights well-done work from students (see Figure 16). Public applause serves two purposes: It recognizes the student who produced the work and it acts as an example of good work for others. Best of show presentations are housed on the course website for reference.

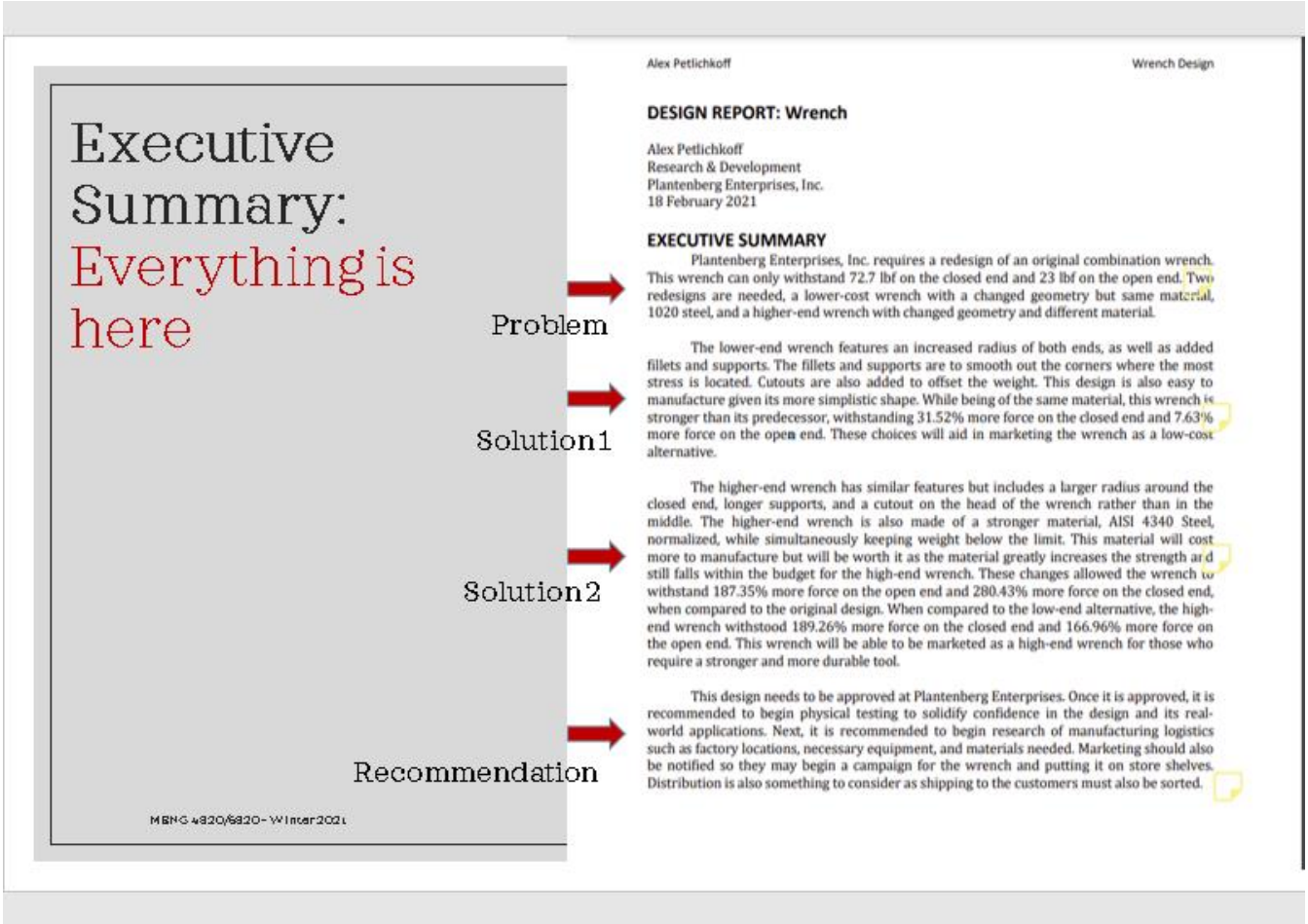


Figure 16. MENG 4920 – Design Report Review – Best of Show.

At the end of the semester in many embedded technical writing classes, students see a table that lists the technical writing skills they have learned (see Figure 17). Each new list presents skills already acquired and adds new ones. This graphic is helpful for several reasons. Students embarking on a co-op job hunt are reminded of the “soft skills” to mention in resumes and interviews. They also see just how long the list is, which adds to a sense of accomplishment. And they have a sense of how the skills build on each other to produce more sophisticated communication understanding and ability.

What You've Learned So Far about Technical Writing – It's a Lot!

Semester	Course	Topics Covered	Skills You Learned
Freshman Fall Semester	ENGR 1020 – Beginning CAD CAD Homework Multi-Tool Design Project with Worksheets, Memo, Detailed Instructions and Wallet Card Instructions	• Audience Analysis: Basic Model • Memo for Boss (Executive Audience) • Descriptions & Instructions for General & Technician Audiences • Research & MLA Refresher • Usability Testing • The Writing Process	• How to identify your audience and how to reach them • How to use a memo format to ask immediate supervisors for feedback, review, etc. • How to describe a product and give instructions for consumers with different skill levels • How to start with a consumer need, then develop a product to meet the need • How to test instructions to see if the target audience can use them • How to write in steps, how to write concisely, how to edit and proofread
Freshman Winter Semester	ENGR 1080 – Fundamentals of Engineering Internet of Things Product Ideation Investor Presentation in Teams Investor Report in Teams	• Audience Analysis: Investor/Executives, Generational Communication • Purposeful Thesis Statements • Rhetorical Strategies • Research & ASME style • Persuasion: Basic & Toulmin models	• How to move beyond writing for a generic "executive" and write for a particular investor-executive using the correct content, tone, etc. • How to focus the project by identifying WHO should do WHAT and WHY • How to develop a communication plan to support your project (rhetorical strategy) • How to support product ideation with consumer, product and market research • How to use ASME in-text citations and References list • How to determine when persuasion is appropriate and the type to use

	ENGR 1080 – Fundamentals of Engineering – cont'd.	• Teamwork & stages of team formation • Investor Presentation • Investor Report • The Writing Process	• How to help teams operate effectively • How to use a process to create a lengthy presentation and how to present to win funding for a new idea • How to use a template to support the presentation development process • How to work in a team to accomplish a long-term goal • How presentations differ from written communication in their purpose and content • How to support the presentation with a polished and credible report • How to use templates to support the writing process • How to continue refining organization, writing, editing and proofreading skills
Sophomore Fall Semester	ENGR 1021 – Intermediate CAD CAD Homework Bell Crank Design Project with Worksheets, Memo, Rhetorical Strategy and Design Report Self-Assessment at the Mid-Term	• Audience Analysis: Technical Boss • Rhetorical strategy • Design Reports & their purpose • Graphics: Matching format to data and audience • Research to support a particular design project • Progress Report	• How to move beyond writing for a generic "executive" and write for a particular technical executive • How to develop a communication plan to support your project (rhetorical strategy) • How to write a design report • How to describe your design process • How to build credibility for your design • How to develop and insert graphics to support your design work • How to find and use references to show how your design fits in • How to assess your progress and make plans for improvement

	ENGR 1021 – Intermediate CAD – cont'd. Product Assembly Design Project with Memo, Rhetorical Strategy and Customer Specifications	• Audience Analysis: Consumer • Rhetorical Strategy • Customer Specifications • The Writing Process	• How to move beyond writing for a generic "general" audience and write for a specific consumer • How audience and purpose affect what content is included and how it is presented • How to describe your product to attract customers and persuade them to make a purchase • How to read project instructions, how to incorporate primary research and graphics into design reports, how to stay motivated over the course of a long-term project

Items for Your Portfolio of Sample Work (make sure to include Final Drafts – without Mark-ups)

Multi-Tool Design Project: Multi-Tool ASB, Worksheets 1-2, Memo to Supervisor, Detailed Instructions, Wallet Card Instructions

ENGR 1080 Project: Investor Report, Investor Presentation, PowerPoint file available

Bell Crank Design Project: Bell Crank ASB, Design Report: Bell Crank, Memo to Supervisor, Rhetorical Strategy: Bell Crank Project

Assembly Specs Design Project: Worksheets 1-3, Memo to Supervisor, Product Specs for Customers, Rhetorical Strategy: Assembly Specs Project

Figure 17. ENGR 1021. Recap of Topics & Skills for Second Years.

Next steps

To date, feedback on the efficacy of immediate assessment has been anecdotal with favorable reports from students, other instructors and employers. In essence, program moderators are hearing that assignments, content and writing process are helpful. As mentioned, it is now time for a more scientific assessment to see whether the program itself is built to sustain the habits of process writing, audience analysis, and reflection.

The assessment will be based on a series of data points: Assignment Grading Rubrics (2015 -pre-embed program and 2016-2021 embed program), Student Course Evaluations, "Engineering Learning Community: Mentorship Program Student Survey," "Semester/Year E&S Co-op Student Questionnaire," "Co-op Experiences – Summer/Year as told by students in Fall/Year ENGR 1021," and performance in the Senior Capstone Design courses. Under consideration is a tracking system or questionnaire to determine how well prepared graduates feel now that they are producing technical writing in the workplace.

In addition to the participation of this paper's authors, the assessment will involve the other engineering and technical writing instructors, co-op employers, a writing assessment expert from the English department, and survey experts from Organizational Psychology.

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References

[1] P. Sageev, P. and C. J. Romanowski, "A Message from Recent Engineering Graduates in the Workplace: Results of a Survey on Technical Communication Skills," *Journal of Engineering Education,* vol. 90, no. 3, pp. 685-693. October 2001. [Online]. Available: https://www.semanticscholar.org/paper/A-Message-from-Recent-Engineering-Graduates-in-the-Sageev-Romanowski/a4b6f0f6f056a913fc6863a7dc400c0dc1532797. [Accessed June 22, 2017].

[2] S. Nelson, "Teaching collaborative writing and peer review techniques to engineering and technology undergraduates," in *Proceedings of the 30th Annual Frontiers in Education Conference: Building on A Century of Progress in Engineering Education*, S2B/1-S2B/5 2000, Kansas City, MO, USA. October 18-21, 2001. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/896636. [Accessed June 22, 2017].

[3] Engineering Accreditation Commission, "Criteria for Accrediting Engineering Programs," ABET, 2011.

[4] Engineering Accreditation Commission, "Criteria for Accrediting Engineering Technology Programs, 2019-2020," ABET, 2019. [Online]. Available: https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-technology-programs-2019-2020/. [Accessed February 22, 2021].

[5] Pacello, J., "Cultivating a Process Approach to Writing: Student Experiences in a Developmental Course," *Journal of the Scholarship of Teaching and Learning,* vol. 19, no. 2, pp. 187-197, March 2019. DOI: 10.14434/josotl.v19i1.23786.

[6] S. P. O'Brien, D. Marken, and K. B. Petrey, "Student Perceptions of Scholarly Writing," *The Open Journal of Occupational Therapy*, vol. 4, no. 3 2016. [Online]. Available: https://doi.org/10.15453/2168-6408.1253. Published by Western Michigan University, https://scholarworks.wmich.edu/ojot/vol4/iss3/8/. [Accessed February 20, 2021].

[7] A. Staton, and M. Rendahl, "Tethering the Classroom to the Workplace through Embedded Writing Instruction," in *Proceedings of the 2014 IEEE International Professional Communication Conference*, Pittsburgh, PA, USA. Oct 13-15, 2014. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/7020366. [Accessed February 15, 2021].

[8] R. Bercich, S. Summers, P. Cornwell, and J. Mayhew, "Technical Communication Across ME Curriculum at Rose-Hulman," in *Proceedings of the 2018 ASEE Annual Conference & Exposition*, Salt Lake City, UT, USA, June 24-27, 2018.

[9] P. Lentz, "MBA Students' Workplace Writing: Implications for Business Writing Pedagogy and Workplace Practice." *Business Communication Quarterly*, vol. 76, no. 4, pp. 474-490, November 2013. [Online]. Available: https://journals.sagepub.com/doi/abs/10.1177/1080569913507479. [Accessed February 23, 2021].

[10] S. Doan, "Contradictory Comments: Feedback in Professional Communication Service Courses." *IEEE Transactions on Professional Communication*, vol. 62, no. 2, pp. 115-129. June 2019. DOI: 10.1109/TPC.2019.2900899. [Online]. Available: https://ieeexplore.ieee.org/document/8669840 . [Accessed February 5, 2021].

[11] M. A. Stellmack, N. K. Keenan, R. R. Sandidge, A. L. Sippl, and Y. L. Konheim-Kalkstein, "Review, Revise, and Resubmit: The Effects of Self-Critique, Peer Review, and Instructor Feedback on Student Writing." *Teaching of Psychology*, vol. 39, no. 4, pp. 235-244. October 2012. [Online]. https://journals.sagepub.com/doi/10.1177/0098628312456589. [Available: February 20, 2021].

[12] A. S. Akdemir and A. Eryerci, "Using writing Templates as Materials to Improve Writing Skills in EFL Classes: An Experimental Study." *Mersin University Journal of the Faculty of Education*, vol. 12, no. 2, pp. 747-756, August 2016. DOI: 10.17860/efd.94338. [Online]. Available: https://www.researchgate.net/publication/307445702_Using_Writing_Templates_as_Materials_to_Improve_Writing_Skills_in_Intermediate_B1_EFL_Classes_An_Experimental_Study. [Accessed: February 20, 2021].

[13] N. Wolny, "How To Create And Use A Template To Write Articles." The Writing Cooperative, May 3, 2020. [Online]. Available: https://writingcooperative.com/how-to-create-and-use-a-template-to-write-articles-7284c6c144f8. [Accessed: January 31, 2021].

[14] ASEE, "Guide for Authors," *Advances in Engineering Education*, 2021. American Society for Engineering Education, Washington, D.C., USA. [Online]. Available: https://advances.asee.org/guide-for-authors/. [Accessed February 23, 2021].

[15] S. K. Gunning, "Designing and Testing Multimodal Instruction Sets: Writing for Real-Life Users," *English Journal*, vol. 107, no. 3, pp. 68-74. 2018. [Online]. Available: https://www.academia.edu/38598938/Designing_and_Testing_Multimodal_Instruction_Sets_Writing_for_Real_Life_Users. [Accessed: Jan. 30, 2021].

[16] A. Shannon, J. Hammer, H. Thurston, N. Diehl, and S. Dow, "PeerPresents: A Web-Based System for In-Class Peer Feedback during Student Presentations," in *Proceedings of the 2016 DIS (Designing Interactive Systems)*, Brisbane Australia, June 4-8, 2016. DOI: http://dx.doi.org/10.1145/2901790.2901816.

[17] D. Cavilla, “The Effects of Student Reflection on Academic Performance and Motivation.” *Sage Journals Special Collection-Student Diversity*, vol. 7, no. 3, September 2017, pp. 1-13. [Online]. Available: https://journals.sagepub.com/doi/10.1177/2158244017733790. [Accessed Jan. 27, 2021].

[18] Mechanical Engineering Department-University of Detroit Mercy. “Template: Design Report: Product/Project Name.” UD Mercy, 2019. [Online]. Available: http://www.engineeringessentials.com/writing/ [Accessed Jan. 29, 2021].