



## **A Guided Approach to Technical Report Writing for Undergraduate Engineering Students**

**Dr. Lindsay Corneal, Grand Valley State University**

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

# **A Guided Approach to Technical Report Writing for Undergraduate Engineering Students**

## **Abstract**

Learning how to write technical reports can be difficult for undergraduate engineering students that have had very little, if any, experience with technical report writing in their high school classes. The laboratory course “Engineering Measurement and Data Analysis” is required for all undergraduate engineering students at Grand Valley State University, with a major focus of this course being technical report writing.

In order to guide the students in preparing technical reports, templates were designed to act as an example of how to present their laboratory results in a technical report format. The templates slowly transitioned the students into writing the reports on their own, without the use of a template. This was done by providing a full template for the first laboratory activity, where the students simply had to fill in the fields of the template with information from their own laboratory activity. For the second laboratory activity, the students were provided a partial template where they had to focus only on writing certain sections of the report and the other sections were provided as a template with fields to complete. The final template was another partial template that required the students to focus on writing the sections of the report that were not the focus of the earlier partial template, and the rest of the report was provided as a template with fields to complete. By the fourth laboratory activity, the students prepared full technical reports without the use of any template.

This guided approach using writing templates was incorporated into the Engineering Measurement and Data Analysis class in addition to technical report writing guidelines and examples that have been used previously. Feedback from the students indicated that the templates helped them understand how to apply the guidelines for technical report writing. One area of concern was that the students could become confused with the clarity of what is to be inserted into the fields of the templates. Updates to the templates themselves will be completed for use in future classes.

This paper presents an overview of the guided approach as well as the outcomes and feedback from the students that participated in the class. The plans for further modifications and improvements to this approach will also be presented.

## **Introduction**

Being able to effectively communicate technical information is a skill required of engineers; however, there can often be a limited focus on or interest in technical writing by engineering students and faculty. It is not uncommon to encounter the thinking that “we are engineers, we are not English majors.”<sup>1</sup> Therefore, engineering students are often required to take a general writing course taught by English or Writing Departments to fulfill writing requirements. Unfortunately, it has been found that courses in general writing are ineffective in improving

technical writing.<sup>2</sup> When students are required to take technical writing courses, there is often the problem that it is a course without content, in that it requires the students to learn the forms of technical communication without having specific subject matter on which the students' can focus their writing.<sup>3</sup>

There is also the common notion that technical communicators should focus on content only, in line with the Latin maxim *res ipse loquitur* (words speak for themselves). Although content is important, it must also serve a particular purpose and technical communication is fundamentally strategic and grounded in the professional environment.<sup>4</sup> Many first- and second-year engineering students have little to no experience in a professional environment and have had very little opportunity to read, let alone write, items of a technical nature. Therefore, to provide them with some guidelines about technical report writing and a topic about which to write can leave the students overwhelmed and unsure where to begin.

Studies of technical communication instruction in engineering schools has focused on which department teaches the technical communication class, whether the classes are required or electives, and how technical communication is integrated across the curriculum.<sup>5</sup> There is little information about specific methods of teaching technical communication and the effectiveness of various approaches. An approach used at New Mexico Institute of Mining and Technology did incorporate the use of templates to assist the Master of Science (M.S.) students in the organizing of information for their thesis.<sup>6</sup>

The Engineering Measurement and Data Analysis course at Grand Valley State University is a one-credit laboratory class that first-year engineering students take. The engineering students must concurrently take the Statistical Modeling for Engineers course, a two-credit class offered by the Statistics Department. The engineering laboratory course is designed to address the ABET (Accreditation Board for Engineering and Technology) student outcomes: an ability to design and conduct experiments, as well as to analyze and interpret data (3b); an ability to communicate effectively (3g); and recognition of the need for, and an ability to engage in life-long learning (3i).<sup>7</sup>

In addition to the measurement and data analysis topics that are the focus of the Engineering Measurement and Data Analysis class, there is also a major focus on technical writing. There are approximately ten laboratory activities completed throughout the semester. The results of the laboratory activities are presented in technical reports, technical memos, or electronic data files.

Technical reports are the first form of technical writing introduced within the course. Because many students are not familiar with technical writing, they are provided a comprehensive guide for technical report writing, which includes an example of a technical report. In previous semesters, the initial report write-ups only focused on two or three of the sections of the technical report at a time (Executive Summary, Introduction, Apparatus, Experimental Procedure, Results and Discussion, Conclusion, and Appendices). After having experience writing all sections of the report, by the fourth laboratory activity, they were required to apply that experience to writing a full technical report.

This approach had benefits in that it introduced the full report in smaller, more manageable sections. It allowed the students to focus on only certain portions of the report at a time, providing them with opportunity to get feedback on their writing of the individual sections. They could then use that feedback when preparing the full report. However, problems encountered with this approach were that the students had trouble identifying where they should include certain details in their report when they were only completing certain sections. For example, when they had acquired extensive data and performed a thorough analysis, they had trouble deciding how to summarize it into just an Executive Summary, Introduction, or Conclusion. When only focusing on the Results and Discussion, they felt they needed to provide context and would include extensive details that belonged in the Experimental Procedure, because it was difficult for them to begin to present their results without explaining where they came from.

To alleviate the problems identified, this segmenting approach was modified to still provide a gradual introduction to technical report writing while supplying the context of how all of the sections are integrated into a complete report. This was accomplished through the use of report templates. The templates were designed to allow the students to write portions of the report themselves while maintaining an overall perspective on how all of the individual portions work together.

## **The Approach**

The guided approach to technical report writing that was developed involved a progressive introduction to report writing over four weeks. This was accomplished by providing a full report template for the first laboratory activity, where the students simply had to fill in the fields of the template with information from their own laboratory activity. For the second laboratory activity, the students were provided a partial template where they had to focus on only writing the Experimental Procedure and Results and Discussion sections of the report and the other sections were provided as a template with fields for the students to complete. For the third laboratory activity, the students were again provided a partial template where they had to focus only on certain portions of the report, while others were provided with only certain fields to complete. For this third report though, the students were required to write the Executive Summary, Introduction, Apparatus, and Conclusion sections. For the fourth laboratory activity, the students prepared full technical reports without the use of a template.

An example of the Experimental Procedure section of the template for the first laboratory activity is shown in Figure 1. During the first laboratory activity, each team of 3-4 students used a mold containing six cavities to produce projectiles. After making the projectiles, the students measured the dimensions to analyze the variability and used a scatterplot to compare the features. For the second laboratory activity, the students fired the projectiles from a launcher. The Experimental Procedure section of the technical report was to be written by the students while other sections of the report were provided with fields to complete within the template. Figure 2 shows the instructions provided for the Experimental Procedure section within the template for the second laboratory activity.

### Experimental Procedure

The volume of the cavities of mold (insert mold letter) was estimated by measuring the depth, L, and diameter, D, of a single cavity and calculating the volume, V, by approximating the cavity as a cylinder, using Equation 3, and then multiplying the volume of a single cavity by six.

$$V = \frac{\pi D^2}{4} L \quad (3)$$

The Alumilite Regular Casting Resin requires equal volumes of resin A and B to be mixed together. To ensure enough resin was mixed, slightly more than half of the total calculated volume, (insert volume used) mL of each, was measured in the graduated cylinders. The cavities of the projectile mold (insert mold letter) were lightly sprayed with silicone mold release. Alumilite resins A and B were then poured into a single disposable mixing cup and stirred continuously for approximately 30 seconds. The Alumilite mixture was then carefully poured into the cavities of the projectile mold, ensuring that each cavity was completely filled without overflowing. Once the cavities were filled, the sides and bottom of the mold were tapped to eliminate any air bubbles. The Alumilite resin was allowed to cure for (insert how long the resin cured). A permanent marker was then used to label the end of each projectile with the cavity number in which it was molded before the rubber mold was flexed to release the projectiles.

Any flashing or rough edges were removed from the projectiles using a metal file. The length and diameter of the projectiles were then measured using (insert measuring tool) and the mass of each projectile was measured using (insert measuring tool). All measurements, along with the measurements from all groups within the laboratory section were compiled and analyzed. The mean, standard deviation, coefficient of variation, minimum, maximum, count, and median were calculated for the length, diameter, and mass of the projectiles produced from mold (insert mold letter) as well as for the entire laboratory section. A scatterplot was then created of (insert quantities compared using a scatterplot) for all projectiles produced in the entire laboratory section.

**Figure 1.** Experimental Procedure section of the technical report template used for the first laboratory activity where the students molded projectiles that would be fired from a launcher in future laboratory activities.

### Experimental Procedure

(Write the experimental procedure that you used in your own words. Remember to write it in past tense and include specific details such as the number of shots fired, the air pressure of the launcher, etc.)

**Figure 2.** Instructions for writing the Experimental Procedure section of the technical report for the second laboratory activity.

The students were not only able to see how the various sections of the report are written and the type of information that should be within each section, but they also received feedback on their own writing of the individual sections. They were then able to apply that feedback to the writing of the full technical reports. The grading of the first three reports written with the templates was designed to be formative rather than punitive. The assignments with the templates were worth 40 points each, while the full technical report was worth 100 points.

To assess the outcomes of this approach, the grades on the full technical reports written during the fourth week of the class were compared between the first semester that the use of the templates was implemented and the previous semester's offering of the course. Because this approach was designed to provide guidance and clarity of the expectations, organization, and mechanics of technical report writing, a survey was given to the students to assess whether these objectives were achieved. This short survey consisted of three questions using a likert-scale (with additional space for comments) to obtain feedback about the templates' effectiveness for clarifying expectations, helpfulness in organizing the deliverables of a laboratory activity, and usefulness as references when writing later reports. There were also two open-ended questions asking the students to identify the aspects that were most useful and what modifications could be made to improve the templates' helpfulness.

## Outcomes

The grades for the full technical report written the fourth week of the semester were compared between the semester when the templates were first used (Fall 2014) to the previous semester when technical report writing was introduced by only writing portions of the report at a time (Winter 2014). In each case, the fourth week was the first week when the students wrote a full technical report. When the template approach was used, the average grades were approximately 4% improved over the previous semester although the standard deviation was somewhat greater for the Fall 2014 semester than the Winter 2014 semester, 12% compared to 10%. This improvement in the performance of writing full technical reports was not significant, considering the large standard deviations. However, the intent was not just to improve the students' grades, but to also help the students in their understanding of technical reports and how they should be formatted.

At the end of the semester that the students used the templates, the students provided feedback on the helpfulness of the templates in the form of a confidential survey. The feedback allowed the students to respond on a Likert scale within the range of agreement with the statements in the survey instrument from "not at all" to "extremely". The results of the survey (shown in Table 1) indicated that the templates had achieved the intended outcomes of helping the students in the technical report writing process.

**Table 1.** Student ratings ( $\bar{X} \pm 1 SD$ ) from survey of template use

Question	Rating (n=76)
1. The templates provided for the first three laboratory activities helped clarify the expectations for writing a technical report.	4.4 ± 0.8
2. The technical report templates helped organize the required deliverables for the laboratory activities.	4.4 ± 0.7
3. The technical report templates were useful to refer to when writing later reports.	4.4 ± 0.8
Possible responses were: 1 = not at all, 2 = somewhat, 3= moderately, 4 = mostly, 5 = extremely.	

The first question of the survey asked the students to assess the helpfulness of the templates for clarifying the expectations for writing a technical report. The students rated this question  $4.4 \pm 0.8$  out of 5 possible points. Some examples of comments that accompanied the responses to this question were: “I wouldn’t have known how to format a report or what type of substance was expected to be included in a report,” “It was useful in the fact that it showed expectations as well as a useful reference for later labs,” and “Without these templates I likely would’ve felt lost writing the reports.”

The second question of the survey asked the students to assess the helpfulness of the templates for organizing the required deliverables for the laboratory activities. The students rated this question  $4.4 \pm 0.7$ . Some examples of comments that accompanied the responses to this question were: “I’ve never done a technical report. By having the templates it helped with the organization for the report,” “The first one laid it all out and they really helped guide me,” and “I was able to see what material went where, which was very useful.”

The third question of the survey asked the students to assess the usefulness of the templates as a reference when writing later reports. The students rated this question  $4.4 \pm 0.8$ . Examples of comments that accompanied the responses to this question were: “I often looked back to get an idea of what was expected,” “Saw what was needed to be included and what was not necessary,” and “I do it for every single one.”

In addition to the three questions with the likert-scale ratings, the final two questions of the survey asked for comments about what the students found most useful about the technical report templates and how they could be modified to better help with technical report writing. One particular response to the question about the most useful aspect of the templates was: “The report templates became less detailed over time. This was very useful because it allowed us to contribute more of our own writing and data to each successive report so that we could focus on learning a few sections at a time. In this way, the reports were not overwhelming and the first independent report was not intimidating.” The suggestions for modifications indicated that some students had trouble determining exactly what they needed to enter in certain fields of the template. Examples of comments that were provided for the suggestions of modifications were: “Some of the discussion topics were very vague and took me a few labs to grasp. Which hurt for the first couple labs” and “Maybe explain what is needed.”

From the survey feedback, it appears that the templates were found to be quite helpful for the students overall. Some adjustments will be made to the templates to help clarify the items that are being asked for in the various fields of the templates. The wording of the prompts for the fields to be completed in the templates will be edited and reevaluated in future offerings of the course. This first use of the templates in the class showed the potential for providing many great benefits to the class. Continual refinement should only improve their effectiveness.

The ABET outcomes that were the focus of the use of the templates were the analyzing and interpreting of data as well as the ability to communicate effectively. Although the grades for the first full technical report that the students write without the aid of a template showed no significant grade improvements as compared to the previous semester where the template

approach was not used, the students' did not feel as overwhelmed when given the task of writing a report on their own. The instructors for the various class sections were also able to refer to the templates when instructing about technical writing. The templates were specific to the laboratory activities, allowing for clear examples rather than general guidelines.

## Conclusion

The implementation of the sequence of three templates to guide students through the process of technical report writing showed promising results. The templates slowly transitioned the students into writing the reports on their own, without the use of a template. Although the students' performance on writing their first report without the templates was only minimally improved as compared to a previous semester, the students' feedback was overwhelmingly positive. The students indicated that the templates had helped with the understanding of technical report requirements. Some suggestions for improvements, however, indicated that editing the templates to provide better details of what should be included in the various fields would improve their ease of use. The templates will continue to be updated and assessed in future class offerings.

## Bibliography

1. Zhu, W., "Faculty views on the importance of writing, the nature of academic writing, and teaching and responding to writing in the disciplines", *Journal of Second Language Writing*, 13, 29-48 (2004).
2. Silyn-Roberts, H., "Using engineers' characteristics to improve report writing instruction", *Journal of Professional Issue in Engineering Education and Practice*, 124, 12-16 (1998).
3. Wilson, C.A.B., "A novel approach to teaching technical writing", *Proceedings of the 2012 ASEE Education Annual Conference & Exposition* (2012).
4. Rus, D., "Technical communication as strategic communication. Characteristics of the English technical discourse", *Procedia Technology*, 12, 654-658 (2014).
5. Reave, L., "Technical Communication Instruction in Engineering Schools A Survey of Top-Ranked US and Canadian Programs", *Journal of Business and Technical Communication*, 18 (4), 452-490 (2004).
6. Ford, J.D., "Integrating Communication into Engineering Curricula: An Interdisciplinary Approach to Facilitating Transfer at New Mexico Institute of Mining and Technology. In *Composition Forum* (Vol. 26). Association of Teachers of Advanced Composition (2012).
7. ABET, *Criteria for Accrediting Engineering Programs*, Baltimore, MD, Engineering Accreditation Commission, October 26, 2013. <http://www.abet.org/eac-criteria-2014-2015/>, accessed Jan. 30, 2015.