

WIP: Short Online Films to Help First-Year Students Write Reports as Engineers

Mr. Michael Alley, Pennsylvania State University

Michael Alley is a professor of teaching for engineering communications at Pennsylvania State University. He is the author of *The Craft of Scientific Writing* (Springer, 2018) and *The Craft of Scientific Presentations* (Springer-Verlag, 2013). He is also founder of the popular websites *Writing as an Engineer or Scientist* (www.craftofscientificwriting.com) and the *Assertion-Evidence Approach* (www.assertion-evidence.com).

Ms. Kaitlyn Pigeon, Pennsylvania State University

Kaitlyn is a graduation senior Industrial Engineering student at Pennsylvania State University. She has been an active mentor within the Women in Engineering Program and in the organization Undergraduate Teaching and Research Experiences in Engineering. During the Spring 2021 semester, she has helped to market the writing reports online tutorial to more Penn State engineering faculty and students. Kaitlyn is looking forward to starting her career in business operations consulting after graduation.

Dr. Stephanie Cutler, Pennsylvania State University

Dr. Stephanie Cutler has degrees in Mechanical Engineering, Industrial and Systems Engineering, and a PhD in Engineering Education from Virginia Tech. She is an Assistant Research Professor and the Assessment and Instructional Support Specialist in the Leonhard Center for the Enhancement of Engineering Education at Penn State as well as a co-founder of Zappe and Cutler Educational Consulting, LLC. Her primary research interest include faculty development, the peer review process, the doctoral experience, and the adoption of evidence-based teaching strategies.

Work-in-Progress: Short Online Films to Help First-Year Students Write Reports as Engineers

Introduction

From grade school through first-year composition, engineering students take several courses on general writing. Although valuable, these courses by themselves are not enough preparation for the challenges that students face when called upon to write as an engineer. Engineering writing is significantly different from general writing. For one thing, the content of engineering documents is, on the whole, both more specific and more complex than the content of essays in general writing courses [1]. Second, not only do the types of audiences vary more in engineering, but so do the levels of knowledge that the audiences have about the content. Yet a third difference is that the expected level of precision in engineering writing is higher than the expected precision in general writing [2, 3]. Still a fourth difference concerns the expectations that engineering audiences have for documents—expectations for titles, summaries, introductions, sections, appendices, illustrations, and equations. Until students learn the principles of engineering writing, a significant gap exists between what those students have experienced in general writing courses and what those students are expected to produce in reports for design courses, laboratory courses, and internships.

Engineering colleges are responding to this gap. For instance, at the University of Michigan [4], the College of Engineering has dropped first-year English from their curricula in favor of increasing the number of credits allotted to first-year design. Now having four credits, this first-year design course has both a design instructor and a writing instructor with increased emphasis on the writing and revising of design documents. Similarly, over the span of two-semester, Ohio State's first-year engineering design course is connected with an engineering writing course [5]. In this course sequence, students perform several short writing assignments, receive feedback on those assignments, and then use that feedback to produce three large documents that document the design process.

However, many engineering colleges do not have the financial or faculty resources to bridge the gap between general writing and engineering writing until the junior year or even senior year when students take a course in technical writing. For example, like many other large public institutions, our institution's first-year composition course is dedicated to a general study of rhetoric [6]. Also, because our first-year design course is only three credits and spans only one semester, the course has little room for another major instructional topic such as engineering writing.

Although a technical writing course certainly can bridge this gap for engineering students, not offering this course until the third or fourth year can pose problems for engineering students. For instance, in many lab courses and design courses that occur during the first three years of study, engineering students are expected to write technical reports. If students have not yet learned the principles of writing reports as an engineer, students run the risk of making major errors of style such as not targeting the audience, not properly emphasizing important results, being imprecise, or not knowing what goes into a title, summary, or introduction. Such errors can lead to poor performance, which can cause students to assume that they are inherently weak at

technical writing. In such cases, many students will cease to put much effort into this skill, which they believe is an inherent weakness [7]. A second potential problem would be if students write ineffectively in those courses, but still pass the courses. In such cases, those students might adopt lower expectations for the quality of future writing tasks in engineering.

Still another problem arises during summer internships. In such internships, engineering students who have not yet bridged the gap between general writing and engineering writing are at a disadvantage when writing emails and reports, especially when employers compare the writing of those students with the writing of engineering interns who have bridged the gap. During the first two years of study, courses such as first-year design, first-year seminar, and measurements laboratory are in a position to help students learn to write as an engineer. One challenge, though, is that many engineering and science professors in those courses struggle to teach writing principles—even when the writing is in their own discipline [8]. The struggle arises both from time constraints and lack of experience teaching such principles. Given that challenge, this work-in-progress paper begins addresses the following research question: *Could short online films help bridge the gap of teaching principles of engineering writing?*

In this paper, we introduce an online series of films that has the goal of teaching first- or second-year undergraduates the differences between general writing (which the students have studied) and the writing a report as an engineer (which the students have not yet studied):

<https://sites.psu.edu/scientificwriting/tutorial-reports/>

In addition, students have links to model documents, templates, additional films, and supplemental tutorials such as the essence of grammar for engineers [9]. Moreover, the website provides teaching materials for faculty: (1) quizzes to ensure that students have understood the content of the films, and (2) teaching slides to reinforce the principles of the films. This paper presents both our methods for developing this online series of films and initial results for how effective the series is. Concluding the paper are our future strategies to assess the research question and to disseminate the film series.

Methods for Developing the Film Series

To develop our online film series, we used the NSF approach of I-Corps™ Learning [10], which is an educational version of a lean design approach based on customer discovery [11]. In short, the process calls on educators to test value propositions about their teaching design (the short films in our case) through responses of customers (engineering students and faculty in our case). Through this process, as educators understand more about what the customers needed, the educators revise the design.

In our application of this process, we interviewed more than 100 engineering students (most in their third or fourth year) who had not seen the films—about one-third of the interviewed engineering students were women. The rationale behind selecting the students who had not seen the films (our prototype) was to discover what the students reflected on as being important in learning to write as engineers. In particular, we asked students about the following:

1. Biggest challenges faced when called upon to write an engineering report
2. Biggest surprises about engineering writing, compared with general writing
3. What they wished that someone had taught them about engineering writing before they wrote their first engineering report.

We also interviewed more than 20 engineering faculty who taught writing-component courses to undergraduates. Our main question to the faculty (who also had not yet seen the films) was as follows: “What are the biggest problems in the report writing of your engineering undergraduates?” Interviews of students and faculty followed the recommendations of the lean design approach such that we posed neutral questions that tested the hypotheses of our value propositions [12].

As shown in Figure 1, our starting point for the online resource (our initial design) closely followed a popular textbook on scientific writing [3]. At that time, we had interviewed only 10 students and 5 faculty members. To create the films, we used a film studio within our College of Engineering. To make those films high quality, we contracted film editors within our College’s Office for Digital Learning. Based on recommendations from our Office of Digital Learning, we decided that no film would be longer than 10 minutes. To limit dead time within the videos, we committed to preparing for each video with a complete script, which increased the time taken to create each video. Moreover, to maintain viewer interest, we incorporated many examples and graphics (either as full frame or beside the speaker).

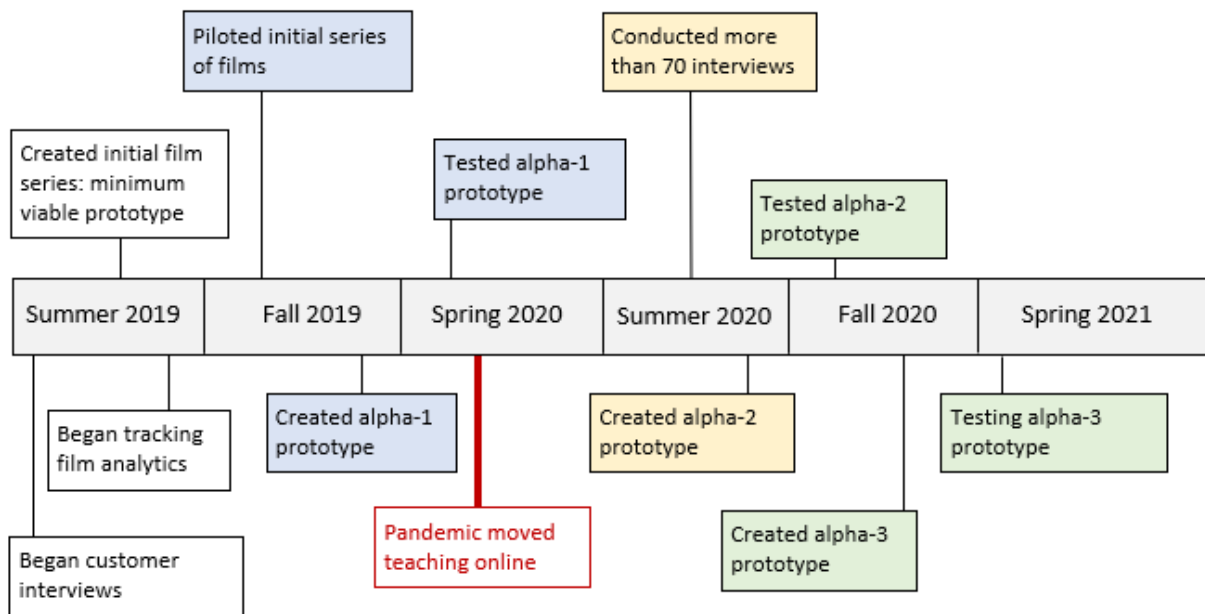


Figure 1. Process for gathering data and revising film series. Using results of customer interviews, surveys of students who have viewed films, and film analytics, we have created four prototypes of the film series since Summer of 2019.

After creating a minimum viable prototype of the film series, we tested the series in various technical courses during the Fall 2019 semester. In these tests, students viewed the film series before a class period, responded to oral questions about the content of the film series during the class, and then completed a short survey about the film series at the end of class. The survey focused on biggest surprises of the film series and suggestions for making the film series more effective.

As a third means of developing our film series, we tracked the analytics of the film series websites and the associated films. In this tracking, we paid attention to the following: (1) how

many views each film received, (2) what average percentage of each film was viewed, and (3) where the films were viewed.

In the second half of the Fall 2019 semester, by incorporating results from the additional interviews done, the surveys, and the film analytics, we revised the film series (see Table 1). Also affecting the revisions were the analytics of the film views. As shown in Table 1, for the 2020 Spring semester and 2020 Fall semester, we repeated the process.

Table 1. Descriptions of Changes to Prototypes of Film Series

Name	Dates	Sources (for Change)	Description of Prototype and Changes Incorporated
Alpha-0	Aug – Dec 2019	Professional course on scientific writing Initial interviews of 5 faculty and 10 students	Series of 7 films focused on reports (films drawn from collection of 40 films on scientific writing) No film longer than 10 minutes All films narrated by faculty member
Alpha-1	Jan – Jun 2020	Surveys of 128 students Interviews of 5 faculty Film analytics	Films tightened (no more than 7 minutes) 2 films redone with student narrators Users now allowed to control speed Captions added to all films
Alpha-2	Jul – Dec 2020	Interviews of 75 students and 10 faculty Film analytics	Series now 12 films with 6 narrated by students No film more than 6 minutes Three new topics: grammar, verb tense, and process of writing in a team
Alpha-3	Jan – Jun 2021	Interviews of 5 faculty Film analytics	Addition of supplemental films and links to tutorials Several films tightened

Preliminary Results

This section presents our preliminary results from the interviews with engineering students and faculty, surveys of engineering students who have viewed the films, and analytics on the number, duration, and location of film views.

Results from Interviews. From our initial interviews of 10 students and 5 faculty, we discovered a preference for a set series of short films (less than 40 minutes in total) for writing reports. From the interviews, we gathered that faculty did not have time to watch a large collection of films to select which ones to assign to students. Moreover, such an assignment would be complex because the faculty member would have to assign several different website addresses to students. Second, in their interviews, faculty requested links to supplementary tutorials on avoiding errors of grammar, punctuation, and usage in technical writing. Third, students voiced preferences for having the films be no longer than 5 minutes. Given this request, we broke up a number of films into two shorter films. Finally, students requested a separate film series on writing professional emails, and faculty requested a series for graduate students on writing research papers. These two series we began developing in parallel to the one on reports.

As mentioned, after creating the minimum viable prototype, we continued our customer interviews of students and faculty until we attained more than 100 students interviews and more than 25 interviews of faculty. These additional interviews revealed important gaps that our film

series needed to address. One such gap was that perhaps the biggest writing challenge that engineering students faced was not about style or form, but about the process of writing in a team. For that reason, we created a film that addressed that subject. In addition, arising from the interviews were two misconceptions that students held about writing. These misconceptions arose from things that the students had learned or gathered from general writing courses, but that did not apply in writing as an engineer:

1. Misconception: Sentences should be flowery
2. Misconception: The longer the document, the better the document

Our revised films sought to dispel these misconceptions.

Results of Surveys. After each pilot test of the film series, the participating students filled out a survey that focused on what they learned and how the film series could be improved. The survey had three open-ended questions:

1. What were the most surprising things that you learned in the films?
2. What did you like best about the films?
3. How could the films be improved?

Participating in the testing of the film series on writing reports were 128 third-year students in the first week of an engineering writing course. Our rationale for testing on third-year students who had not yet taken a technical writing course was that these students (unlike first-year students) had tried to write as engineers in engineering and science courses. Moreover, a significant number had tried to write as engineers in internships. Therefore, these students had a better appreciation (than first-year students did) in what was expected in writing as an engineer.

The four most surprising things that the third-year students learned about engineering writing from the films were the following stylistic aspects:

1. writing in sections,
2. incorporating illustrations and equations,
3. the importance of being precise and clear, and
4. the importance of avoiding ambiguity

One student specifically noted that several aspects of the films were surprising since those aspects were “different” from what that student had learned about the general essays in high school and first-year composition. About 15 percent of students shared that they were surprised to learn about the importance of understanding their audience. On this point, several students claimed not to have realized that different types of audiences often existed for a technical document. As one student wrote, “I simply thought that because the writing is scientific, it is intended for a learned audience when in reality, scientific writing can be intended for different audiences,” such as users of an instruction manual or for decision makers of a project. These findings supported our decision to keep those details in the film series.

With regard to the question on what students most liked about the films, the top comment concerned *the high number of examples and the quality of those examples*. The second portion of the comment was not surprising given that the examples had been vetted by so many professional engineers. Also appreciated were that the films were clear, concise, and engaging. Many students also appreciated that the films were divided into digestible lengths. As one third-year student wrote, “I obtained more information [from these films] than I usually would in other classes where the online lectures are thirty minutes or longer.” Some students noted that they liked how the films compared and contrasted engineering writing with general writing. One third-year student emphasized that “[the] films were so well produced and the information was

so clearly conveyed that [the films] made me excited to learn how to create technical documents.” One takeaway from these comments was that our investment to produce professional films was worthwhile.

During the testing in the Fall 2019 semester, the top response for suggestions on how to make the films more valuable or interesting to watch was allowing users to change the speed of the videos—for these tests, not all videos had that feature. Other suggestions in that same semester were to add captions and to have different speakers. After analyzing these responses, we added the ability to change the video’s speed on every video. Second, we decided to provide captions for all the films once we were confident about a film’s wording. Third, while all films the first prototype of the film series were narrated by a faculty member, now most of the films have student narrators.

Results of Google Analytics. Perhaps the best measure for the success of an online education film series, such as what we have created, would be the number of film views each semester and the average viewing percentage of those films. Although such an analysis requires viewing the film statistics over several fall-spring-summer cycles, this section presents preliminary numbers and insights from viewing from 1 August 2019 through 30 April 2021.

Shown in Figure 1 and Table 1 are the film viewing statistics for this time period. As seen in both illustration, the number of film views vary significantly from month to month. However, as is evident from Figure 1, the number of film views in academic year 2020 – 2021 is dramatically higher than in academic year 2019 - 2020. What is not clear is how much the pandemic has affected that increase, and whether those numbers will drop back 2019 – 2020 levels after the pandemic has ended. Future work will explore the impact of the pandemic on the use of these videos.

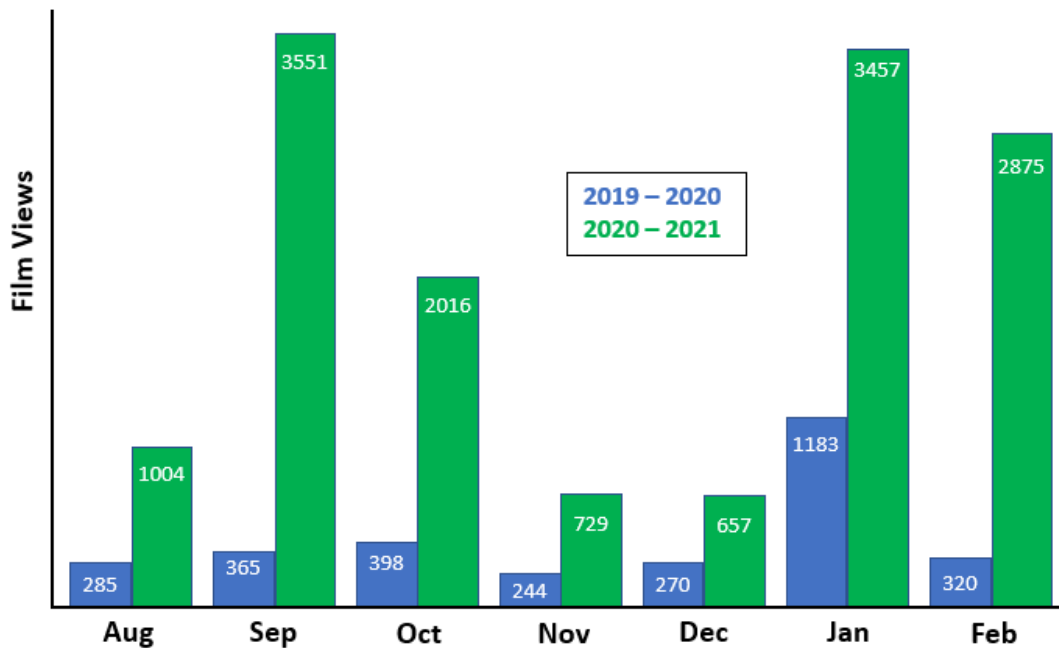


Figure 2. Film views for series on writing engineering reports. The graph compares several months (in blue) from the 2019 – 2020 academic year with those (in green) from the 2020 – 2021 academic year.

Although the hometown of our university (State College, Pennsylvania) viewed the most films for many months, other places had significant numbers of views. What those high numbers in other places suggest is that other schools (in some cases, high schools and middle schools) have incorporated the films into their instruction. Supporting that claim is the high number of views in Blacksburg (Virginia), Killeen (Texas), and Rapid City (South Dakota).

Table 2. Film viewing statistics for film series on writing a technical report over three semesters: Fall 2019, Spring 2020, and Fall 2020.

Month	Film Views	Time	Average % Watched	City with most views, # of views
Aug 2019	285	20 h	53	State College, PA 157
Sep 2019	365	27 h	69	State College, PA 133
Oct 2019	398	26 h	65	Middletown, PA 116
Nov 2019	244	10 h	55	Central District, Hong Kong 20
Dec 2019	270	7 h	56	Glen Ellyn, IL 14
Jan 2020	1183	64 h	54	State College, PA 390
Feb 2020	320	19 h	65	State College, PA 117
Mar 2020	422	16 h	55	Macon, GA 27
Apr 2020	670	35 h	64	Abilene 113
May 2020	686	33 h	66	Medellin, Columbia 89
Jun 2020	419	19 h	61	Miami 14
Jul 2020	515	22 h	66	Taipei, Taiwan 34
Aug 2020	1004	50 h	65	State College, PA 192
Sep 2020	3551	179 h	71	State College, PA 746
Oct 2020	2016	85 h	68	Killeen, TX 264
Nov 2020	729	26 h	62	Houston, TX 24
Dec 2020	657	23 h	63	State College, PA 62
Jan 2021	3457	191 h	77	Blacksburg, VA 1355
Feb 2021	2899	164 h	80	Blacksburg, VA 982
Mar 2021	3343	209 h	70	Blacksburg, VA 582
April 2021	1432	96 h	74	Rapid City, South Dakota 253

Conclusion: Future Strategies to Assess Effect of the Film Series

This paper has presented the creation and continual improvement of a series of short films to help first- and second-year engineering students learn to write as engineers. In particular, the online resource seeks to teach engineering students the differences between general writing and engineering writing. Our assessment of the film series so far is that the film series is successful, but still requires assessment. For instance, is the perceived improvement a result of actual diffusion into technical courses or is it a passing result of the pandemic? If that assessment confirms the success of the preliminary results, then we should make efforts to disseminate the series.

Plans for assessment include surveying and interviewing students at Virginia Tech, where the tutorial is being used in a required 1-credit writing course for junior mechanical engineers in Spring 2021. Such surveying should attempt to determine the effect that the tutorial has had on the writing of the students. Additional survey assessment is being conducted on the effect of the videos on student perceptions of their fixed or growth mindset with respect to engineering communication [13]. Do students think they can improve their communication skills or is it an innate ability that they cannot really change? Pre- and post-surveys will be used at the beginning of the semester (collected in January 2021) and the end of the semester (planned data collection in May 2021). The survey results will be triangulated with student reflections from the course to create a more complete picture of the overall student experience in the course as well as watching the videos and implementing lessons learned.

In the future, we intend to continue with the NSF approach of I-Corps™ Learning [10] and perform more interviews of our two customer segments: (1) the engineering students who learn from the tutorials, and (2) the engineering faculty who assign the tutorials as part of a technical course. Moreover, we intend to develop and assess our film series on writing emails for undergraduate engineers and our film series for graduate students and undergraduate researchers on writing research papers.

To disseminate these tutorials, we intend to advertise the short film series on writing reports, writing research papers, and creating presentations (established in 2017) to engineering faculty around the country. In addition, we intend to advertise our film series on writing emails to technical writing teachers and students pursuing internships. Finally, we intend to advertise all of these tutorials to groups such as the Engineering Ambassadors Network that provide professional development training to undergraduates. For context, the sum of views from all of our films was more than 80,000 in 2020 and more than 50,000 for 2021 (up through May 15).

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