Strategies to Improve Engineers' Writing of Executive Summaries

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Students in a U.S. civil engineering department had been struggling with writing executive summaries for their final senior design course projects to be reviewed by an advisory board panel. Over the years the advisory board had been complaining about the quality and what was being communicated in the summaries. This led to a collaboration with a writing consultant at the university to provide instruction on the executive summary. This paper addresses the framework used for the intervention employed to help these students write better executive summaries. It also explores the improvement of the summaries based on the intervention adapted for the course coming from a background of genre theory and employing tools from genre analysis. The study examines the writing of executive summaries from two semesters before the intervention and two semesters using the intervention using advisory board comments to identify improvement or lack thereof in the students' ability to complete the executive summary assignment.

One aspect of the senior design course is the transformation of a student engineer mindset to that of a practicing engineer mindset. This transition can be a struggle as students learn to shift their thinking, speaking and writing away from the student persona that they have had for many years. This identity shift can lead to new stumbling blocks that do not exist in the realm of university student engineer persona. Winsor (1996), Dannels (2000) and even more recently Parkinson, Demecheleer and Mackay (2017) have explored the transition of developing an employed engineer persona. This shift in identity is reflected in writing as a student adjusts to the genre of the workplace and adapts to that workplace's cultural engineering identity. This shift in writer identity creation can be compounded by the lack of practical writing help in technical communication books (Wolfe, 2009, 2011). Wolfe (2011) notes that technical communication books have shifted away from writing practice assignments to focus more on the overall written product than on how to create the product over the years and assuming more of a humanities bias in presentation of writing practices.

There are elements of the written engineering work that may not become evident in engineering courses or in a technical communication course. Engineers need to learn these genre conventions on their own typically within industry positions or academic positions (Patton, 2011). One such occluded genre is the executive summary. This genre is often only given brief mention in textbooks (Markel, 2016) or writing reference books (Budinski, 2001; Silyn-Roberts, 2005) leaving a gap in knowledge of how to begin writing an executive summary. Students may also not get enough practice or training in summarization regardless of field and in general struggle with the higher order writing demands (related to organization, audience and purpose, development of ideas; Bean, 2011) necessary for summary writing.

Engineer Writing

        Winsor (1996) gives a clear description of how engineering undergraduate students develop their wring skills over the course of their years of higher education. Patton (2011) has done work with civil engineering departments exploring the ways that both students and faculty have learned to write within the discipline. Conrad (2017, 2018) identifies specific linguistic choices between students and practicing engineers when writing. Conrad (2017) analyzed the sentence structure between students and practicing engineers, whereas Conrad (2018) focused on the use of passive sentences between students and practicing engineers. Conrad notes that technical communication books may not truly reflect the needs what is required of practicing engineers. Parkinson, Demecheleer & Mackay (2017) explored the linguistic features of carpenter trainee diaries during an on-campus year and then those written in later years showing a progression of adjusting to an impersonal stance in writing as the trainees become more familiar with the conventions of the field.

        Researchers have also looked into the writing of engineering students in capstone courses in attempts to identify the needs of students (Ford & Teare, 2006; Robinson, Calvo-Amodio, Parmiagiani & Burton, 2015; Baker, MacCauley & Geiger, 2015; Fries, Cross, Zhou & Verbais, 2017; Blicblau & Dini, 2012). These various attempts to identify student writing improvement indicate that students struggle with the transition from student writer to workplace writer. One reason for this is that students may carry the belief that writing is not important in science, technology, engineering and mathematics (STEM) fields. Another similar reason could be that the required university composition course was focused on elements of writing that may not have been perceived as relevant in STEM fields. Often it is industry partners that drive the need to improve student writing and address changes in the writing curriculum for engineering courses. One way to explore and improve the writing needs of engineers is through genre theory and/or genre analysis.

Genre Theory and Genre Analysis

        Genre, according to Miller (1984, 2014), is something that defines the context for which a piece of writing is written. Thus a genre's function relates to the context in which it is used, such as the contexts of different disciplines. Students need to learn genre as part of their acculturation to higher education as well as the workplace. Reiff and Bawarshi (2011) reveal how students can either use previous genre knowledge and adapt it to new settings, or continue to use the same known genre regardless of the task assigned. Similarly, Artemeva and Fox (2010) show that just because a student knows genre conventions does not necessarily mean that the student can produce those genre conventions. However, there are scholars (Freadman, 2012, Bawarshi, 2016) who argue against teaching via genre theory in that it limits students in their ability to think for themselves and stifles creativity. Such a view is likely true in creative writing or other humanities fields as opposed to technical writing fields such as STEM rooted in positivist/post-positivist epistemology.

Genre analysis, on the other hand, is rooted more in English for Specific Purposes (ESP) and examines the elements of a particular genre in order to help teach that genre to learners of English. From an ESP perspective "genre refers to a class of communicative events, such as academic essays, research articles, theses and dissertations" (Paltridge, 2014). Genre analysis methods are useful not just for learners of English but can help non-learners of English have tools to support their transition to a new writing environment. Through genre awareness students can employ the writing features that provides them with more agency with their readers.

Researchers in ESP have explored the genres of the college application essay (Johns, 2015), the laboratory report (Parkinson, 2017) amongst other workplace genres. These studies reveal aspects what may be considered insider knowledge to others. Johns (2015) identifies how the application essay or personal statement differs from the standard five-paragraph essay.

Parkinson (2017) examines how the student laboratory report differs from the research article on which it is based. Through genre analysis studies there is a greater understanding of what is expected of an academic writer to achieve the required genre expectations. Even though ESP tends to focus on the needs of students learning the language of English, the results from genre analysis studies can benefit all students regardless of language background when it comes to learning unfamiliar genres in academia.

Executive Summaries

The executive summary comes at the beginning of a technical report giving a summary of the document. Often technical communication textbooks neglect to provide clear information about how to write executive summaries. One preconceived idea that exists about the executive summary is that it is similar to an abstract in that both summarize information from a larger text. However, this is not the entire story. Jewinski & Jewinski (1990) state that "an executive summary presents the general aims of a document, a brief guide to its contents and a list of recommendations for action" (p. 35). This view of the executive summary puts a lot of pressure on students to learn proper summary writing skills as well as technical writing skills to produce a document and executive summary that will be appropriate for the workplace or a senior design project. With limited literature available on writing executive summaries for engineering, beyond Jewinski and Jewinski (1990); it is hard to develop material to help students succeed in writing an executive summary. More recent references such as Markel (2016) or Silyn-Roberts (2005) only give a brief mention of the executive summary as something that may be required in some circumstances. Other references for writing in engineering mention the executive summary as part of an appendix, with limited information on what is required other than an example summary (Budinski, 2001).

This study will help demystify what should be included in a student executive summary.The study will identify the moves required in an executive summary. The study will also use comments from the senior design's course advisory board about the quality of the summaries as a way to determine improvement or lack thereof.

Intervention Description

In an attempt to improve the executive summary writing, I (first author) wanted to identify information about executive summaries. I started with contacting the advisory board members to learn what they wanted to see in an executive summary. The most useful comment was to answer the five Wh and one H (Who, what where, when, why and how) questions. Another board member shared some industry examples of executive summaries that would need to be anonymized before sharing with students. In addition to this information, I also searched literature to identify elements of executive summaries. This search lead to limited results beyond Jewinski and Jewinski's (1990) book on executive summaries and general information based on the field of business. Reviewing the technical communication textbook used by the university (Markel, 2016), it had only few paragraphs on executive summaries for reports, without much information on how to write an executive summary.

Using this limited available information, I created a power point addressing the purpose and the audience of executive summaries. Addressing these things helped the students break away from the student mindset of assignments of writing solely to a teacher audience. I also looked at previous attempts to improve the writing of executive summaries used in the class, and used some examples work from prior semesters for students to analyze prior to the lecture. The class also had a discussion about the examples read based on their own analysis of the different readings. It may have been through this self-analysis of summaries that the students learned the value of headings for the executive summary even thought that was not explicated taught or presented. After the lecture and review of the power point the students wrote their executive summaries. With the submitted summaries, the students were split into small peer review groups separating students by expertise (ie. students with one type of expertise within the field of civil engineering (i.e. structural) would review summaries written by students with a different expertise (i.e. water resources)). After the peer review portion of the class period, there was a whole class discussion regarding the any action that students could take to improve their summaries.

In the peer review session, students used non-evaluative feedback questions to help guide their peer review sessions. The three questions came from Elbow's (1998) non-evaluative sayback process for writing feedback: non-evaluative sayback, non-evaluative pointing and non- evaluative questioning. The questions on the peer review sheet were: 1. Write what you hear is the topic of the project as fairly and faithfully as possible. 2. What parts of this piece of writing stand out to you? How and why do they get your attention? 3. What parts of this piece of writing raise questions for you and why? These questions kept students from focusing evaluation but allowed them to think about improvement of the executive summaries not just their individual summary but in general.

Analysis Procedures

Analysis began with an initial read of all the summaries for the semesters in the study.There was a goal to identify any common structural features of the documents. This initial review sought to identify what features if any were consistent throughout all the documents. The features identified in the summaries from the semesters of the intervention

were used to review the summaries from the previous year(s). Once the structural features of the summaries were identified, one of the second authors read the summaries looking for the same structural elements to confirm the structural patterns.

Then the board comments/scores were also collected for the semesters used to identify any patterns of improvement. This strategy did not work out as planned due to a few anomalies involved in the semesters included in the study. There was no clear evidence of improvement between the semesters studied. As a result, word counts of the summaries, and other linguistic features (number of pages, use of first person pronouns, use of headers, font type) were included to identify any patterns in the writing between the semesters involved. The linguistic features totals were analyzed per year as opposed to per semester to even out the number of participants discrepancies between the semesters (year one had twelve groups the first semester and eleven groups the second semester, year two had eleven groups the first semester and twelve the second semester). An analysis of variance (ANOVA) and chi-square tests were used to compare the linguistic features of the summaries conducted using SPSS software.

Preliminary Analysis

A preliminary review of the summaries from the two years, shows that the summaries from the two semesters of the intervention followed a structured section breakdown. The summaries followed the basic format of a Background section, Project Purpose section, Design Details sections and finally a section addressing the costs for the planned design. A majority of the summaries from the semesters prior to the intervention included these ideas, however the information was presented in such a way that it was not easy for the reader to identify the information. The summaries also included digressions into reporting how the students conducted the senior design course as opposed to the details of the project. After fall 2017 semester the oral feedback from the board was generally positive regarding improvement in the executive summaries. However, comparing the scores between the four semesters there was no obvious improvement in the summary writing. One reason for the initial lack of improvement over the first two years studied is that there was an instructor shift (prior to the years studied) who in the second semester of teaching the course was uncomfortable with students slacking off in senior design and quite a few students failed the course that semester. When repeating the course Fall 2016 these students had high motivation to write good executive summaries. The board members themselves may have had more sympathy for the students repeating the course and not grading as critically as before.

Structure Analysis Results

The summaries from the two intervention semesters typically had four sections with headers covering the project's background, the project's purpose, design details and cost information. These same elements were included in previous semester summaries, but the information was not as easily identifiable the way the summaries were written. The students who used headers in their summaries made it much easier for the reader to find the appropriate information about the project.

A chi-square test found significance in the use of headers in the executive summaries between the year prior to the intervention and the year of the intervention, at $p < 0.001$ with a Cohen's d of 1.2247. The significance in the usage of headers indicates that the intervention was successful in helping students to organize and present their summaries in such a way that it was easy for the reader to understand and follow the project. Over the course of the intervention students were never explicitly told to use headers. At best they were encouraged to use them as a way to present the content in a way that it was easier for the reader to find important or relevant information. This indicates that students were internalizing the importance of the audience for their documents and demonstrating critical thinking regarding their writing. Audience awareness in writing assessment has long been a key factor for students as well as assessment developers for many years (Cho & Choi, 2018; Kakh, Mansor & Zakaria, 2014; Wiggins, 2009).

Board Member Feedback

Reviewing the semester debrief meeting minutes from the advisory board meeting at the end of the four semester studied, there is no clear indication of improvement in the board's attitude toward the executive summaries. The minutes from the Fall of 2016 had minor comments on the executive summaries. The two main comments were 1) to avoid stating negative things to the client and 2) that the students were more organized and had better grammar that previous years. The improved organization and grammar could be a result of the high number of repeating students in the course that semester. In contrast Spring 2017, there were multiple comments about the executive summaries written by the different student groups. The comments ranged from weak, vague, basic, not the greatest to good depending on the group. An overall comment about the summaries was that the project purpose was not defined and that grammar needs work. Fall 2017 (the first semester of the intervention) there was almost total agreed improvement by the board. The comments addressed a lack of professional tone, meaning that the summaries sounded too much like a conversation. The other major comment was that there needed to be some quality control/assurance in the summaries. The meeting minutes from Spring 2017 had no direct mention of the executive summaries. This could possibly indicate that the board members were seeing an improvement in the product.

As mentioned previsouly, the first semester of the intervention there was a mix of feedback from the board. Some were happy to see improved summaries and some were still not that happy with the summaries. The analysis of the board scores shows a lack of improvement based on the intervention. There could be some reasons for these limited improved scores. One is that board members read the summaries at the surface level looking for the main ideas. The board members also may expect summaries similar to what they get from their own practices from professional engineers.

Another possibility is that the first semester of summaries included in this study had a high number of students repeating the course. Board members could have shown sympathy to this particular group of students giving them higher summary scores. An explanation for the limited improved scores is that students can regress in their surface level writing skills as they

learn new genres (Condon & Kelly-Riley, 2004). The engineering students could have regressed in the surface level writing skills as they progressed in their critical thinking skills for their final executive summaries. There could also be writing features related to the authoritative stance often found in STEM writing (Fang, 2005, 2008) that are not evidenced in the students writing (related to the professional tone comment by the board) These senior design students may not have the confidence in their designs to feel comfortable taking an authoritative stance writing their summaries and/or reports. This phenomena was also seen in Artameeva & Fox (2010) who identified that even though students knew what should be included they were not always able to produce that level of writing in their own documents.

Conclusion

The results from this study indicate suggest that executive summaries need to include the following four features, background information to the project, a statement of purpose for the project, design details about the project and information about the costs of the project. Using headers to help the reader locate the most important information also helps the presentation of the summary. In addition, it appears that the advisory board prefers to see clean, error free summaries. This study also indicates that students need more practice in the elements of authoritative writing require for engineering disciplines.

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