An Exploratory Study of Far Transfer: Understanding Writing Transfer from First-Year Composition to Engineering Writing-in-the Major Courses

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Abstract: This study aims to investigate how engineering undergraduates perform writing transfer from first-year composition (FYC) to engineering writing-in-the major courses. A sample of seventeen engineering students' Junior Writing Portfolios, containing FYC research papers and engineering lab reports, was chosen for analysis in five broad rhetorical categories including invention, disciplinary knowledge, audience awareness, arrangement, and style. Informed by Yancey, Roberston, and Taczack's 2014 study of writing transfer in composition courses, we grouped 17 engineering writing samples into three types of prior knowledge as identified in their study: remix, assemblage, and critical incidents. We found that the remix group students (n = 9) demonstrated an ability to integrate new engineering disciplinary knowledge into the schema of the old FYC knowledge. We observed a mixture of productive and unproductive transfer from FYC courses to engineering major courses with the assemblage group (n = 3). The critical incident students (n=5) struggled with multiple aspects of rhetorical principles, and they received the lowest scores in audience awareness and arrangement. Results from an accompanying focus group comprised of engineering students reported their perceptions of the similarities and distinctions between FYC assignments and engineering lab reports. These combined results suggest that students developed an understanding that genre features are genre specific and informed by disciplinary contexts.

Introduction

As we know, writing across the curriculum (WAC) and writing in the disciplines (WID) have produced important changes in higher education over the last 40 years. WAC/WID approaches to teaching writing support university-wide writing experiences, introducing students to discipline-specific genres, formats, and conventions for thinking and writing professionally within the discipline (Russell, 2002; Thaiss and Porter, 2010). Furthermore, as Carter (2007) notes, an important role of WID programs and/or courses is to address the ways in which WID is not just a matter of addressing disciplinary writing conventions, but also a matter of understanding how students come to "know" and "do" the disciplines as part of the processes by which they become writers in the discipline (388). With respect to this WAC/WID role, this study looks at how we might come to better understand and improve the writing-in-the-discipline experiences of undergraduate engineering students in particular.

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Since their early implementations in the mid-seventies at some universities, such as Ohio State University, the integration of writing assignments within engineering courses is increasingly reported not only to reinforce communication skills (Andrews, 1975), but also to enhance disciplinary knowledge (Burke et al., 2012), problem-solving skills (Thompson & Alford, 1997), and critical thinking (Cooney et al., 2008). Likewise, the Accreditation Board for Engineering and Technology (ABET) has addressed in criterion 3-3 that "an ability to communicate effectively with a range of audiences" in professional contexts is essential for accreditation (ABET, 2019). For this very reason, engineering programs in the U.S. have implemented extensive writing components into their curricula. Most engineering undergraduates are exposed to writing curricula such as first-year composition (FYC) courses in their early program of study, some form of writing in the major courses, and technical communication courses before graduation. Yet even with these extensive writing curricula, many engineering educators still report that engineering students have difficulties meeting the expectations of writing within the discipline and in courses in the major (Calvo & Ellis, 2010; Yalvac et al., 2007).

While WAC and WID have developed to expand and better support writing-in-the major experiences for engineering students, how engineering students transfer their knowledge of writing from one educational context to another is not well understood, particularly in cases of transfer across different disciplinary contexts. As such, this paper draws on transfer of learning theories to investigate how engineering students' writing transfer occurs from FYC courses into sophomore/junior-level engineering courses. More specifically, we investigate the transfer of prior knowledge as evidenced in students' junior writing portfolios at our institution. Given the disciplinary distinctions between FYC and engineering lab courses, we apply the term far transfer (Perkins & Salomon, 1992) to highlight the differences in writing assignments, purposes, and contexts while also attentive to shared expectations and conventions across these academic writing assignments. Far transfer functions in these contexts as disciplinary "distance" whereby students nonetheless make writing knowledge connections across disciplines housing particular purposes, audiences, genres, and genre conventions in writing tasks and genre construction. The results of our research and findings suggest that in the case of far transfer, explicit attention to rhetorical knowledge, genre, and audience awareness in both courses can serve as a useful bridge to better support writing transfer across these two distinct disciplinary contexts (here, from FYC to engineering writing-in-the-major courses), as well as in other cases of far transfer and academic writing, presumably.

Rationale and Context

As identified by Perkins and Salomon (1992), learning transfer focuses on how past learning experiences impact learning and performance in new situations and contexts. This theory focuses in particular on how learners use prior knowledge from past experiences, also referred to as the transfer source, and apply and adjust that knowledge in a new situation, identified as the transfer target. Given its emphasis on prior knowledge, Perkins and Salomon's transfer theory provides a useful theoretical framework for better understanding the writing experiences of undergraduate students as they adapt to the contexts and expectations of writing in their majors. As Donahue (2012) notes, while most upper-division WAC/WID courses are "built on a sense of linear connected development across experiences" (147), writing transfer remains uneven and difficult to identify. This difficulty is perhaps more pronounced in instances of far transfer of learning.

Indeed, mapping and understanding writing transfer is difficult because it is a complex process with multiple and varying influences and motivations. Prompting us to rethink how we define, study, and assess writing transfer, Beaufort (2007) argues the need to re-situate our focus on genre to address a broader theory of discourse communities, and Nowacek (2011) redefines writing transfer as both a cognitive and rhetorical process of "recontextualization." Driscoll and Wells (2012) advise that students' dispositions can have both positive and negative impacts on writing transfer, while Wardle (2012) identifies a "problem-exploring" disposition as a catalyst for creative repurposing by students that can facilitate writing transfer. Recently,

other scholars have identified five key threshold concepts as epistemological frameworks that might enable and/or accelerate writing transfer: writing as an activity; writing occurs in a context; the role of reflection in writing development; genre awareness; prior knowledge, attitudes, and beliefs (Adler-Kassner et al. 2017).

Theories of writing transfer, therefore, allow for a more complex understanding of the rhetorical situations, knowledge, and systems that students must navigate as they move from discipline to discipline. While much research on writing transfer focuses on the first-year composition context, an understanding of writing transfer in WAC/WID contexts is also relevant and of vital significance. Examples of such studies include a call to focus on genre in order to allow for a broader understanding of discourse communities (Beaufort 2007); emphasis on how transfer theory can inform the design of institutional writing across the curriculum programs (Melzer 2014); a study of the facilitation of dynamic transfer at UC Davis (Hayes et al. 2017); and a call for a transdisciplinary approach to writing transfer in WAC/WID studies that better addresses the "nuanced complexity" with which students navigate unfamiliar writing situations (Hendricks 2018). Additional examples include case study analyses of writing-related dispositions of students in science laboratories (Reynolds & Thompson, 2011; Moskovitz & Kellogg, 2011; Ferzli & Carter, 2005).

With our emphasis on undergraduate engineering majors, a significant WID context in many colleges and universities, our study contributes to and furthers WID research within technical fields. Winsor's (1996) landmark research establishes an understanding of the rhetorical nature of writing as an engineer in the field, wherein she subsequently argues that engineers would then benefit from a rhetorical and genre-focused writing pedagogy. Miller (1998), too, argues for a rhetorical understanding of technology and technical communications. More recently, scholars have focused on the relationship between genre and identity formation in technical fields (Emmons, 2009), as well as on observations regarding what that might mean for undergraduate writing instruction for engineering majors (Artemeva, 2009). One notable study is Ford's (2004) research on what kinds of rhetorical knowledge engineering students transfer from technical communication into engineering courses, wherein she calls for more research on curricula focused explicitly on writing transfer.

Collectively, these studies suggest the need for reframing questions about writing transfer to observe what happens across the curriculum, to situate first-year writing as one part of what makes up a student's university-wide writing experiences, and to thus embrace the role that WAC/WID programs can provide in fostering both writing transfer and research on transfer (see Anson & Moore's 2017 collection, in particular). Our research attempts to address part of this need by examining the writing transfer of engineering undergraduates from FYC to entry-level engineering major courses. In order to investigate the far transfer of engineering undergraduates' writing at our own institution, we analyzed the Junior Writing Portfolios (JWPs) of engineering students from the School of Engineering and Computer Science at Washington State University Vancouver. Part of our institution's nationally recognized writing program, the JWP serves as a useful tool for comparing student writing artifacts across disciplines.

Methodology

All Washington State University (WSU) students are required to submit a JWP as a mid-career writing assessment. Submitted by students during the first term of the junior year, it is designed to assess students' preparedness for the kinds of writing tasks they will be asked to perform in upper-division courses. Each student's portfolio includes three graded college-level papers. Students are encouraged to select writing samples that represent their best work across a range of classes and genres. Once submitted, the portfolio is evaluated by a trained group of faculty from across the disciplines in the institution. The JWPs can include a range of written artifacts (genres) from across courses and disciplines; JWPs from engineering students typically contain one or two papers from general education writing courses and one or two papers from engineering courses.

According to the JWP assessment results for engineering students from 2010-2014, we noticed that nearly 20% of engineering students (n = 233) received a "needs work" rating from the institution's JWP, compared to less than 10% of students in other programs (n = ~1200). These assessment results suggested that approximately one fifth of our engineering students' best writing samples demonstrated a need for further writing support in the major (as a result of this "needs work" assessment, students are required to complete an additional one- or three-credit writing course to support upper-division coursework). As such, we found that engineering undergraduates' difficulties in meeting writing expectations posed a problem at our own institution as well. Consequently, we established the following research questions:

- Which rhetorical features do engineering students perform well (or struggle with) in FYC courses and/or engineering major courses? And why?
- What writing skills do engineering students productively (or not so productively) transfer from FYC courses to engineering major courses? And why?
- What are engineering students' perspectives on writing in FYC courses and engineering major courses?

To conduct this study, we used a mixed-method approach (Creswell & Clarke, 2017) so as to better understand the complexity of the writing transfer context and processes in this context. Both quantitative and qualitative data were collected through both direct and indirect assessment methods. For direct assessment, a group of engineering instructors and engineering graduate teaching assistants produced quantitative data on rhetorical characteristics by rating students' artifacts in JWPs. To provide qualitative data to complement this quantitative data, we conducted another direct assessment in the form of genre analysis (Swales, 1990) of select writing sample artifacts. For indirect assessment, we conducted a focus group of undergraduate engineering students to identify how engineering lab reports are understood (or not) as a genre and to determine student's understandings of similarities and differences across the disciplines (English and engineering) with regard to writing expectations. We merged quantitative and qualitative information through a fully integrated mixed methods approach (Teddlie & Tashakkori, 2009) to produce meta-inferences on writing transfer of engineering undergraduates. Research methodology, findings, and results are discussed below in detail.

Direct Assessment: Rhetorical Characteristics

In order to provide quantitative data, a group of four engineering faculty and two engineering graduate teaching assistants assembled to assess patterns of writing in engineering students' JWP writing artifacts over a three-day assessment session during the summer of 2015. All of the raters had experience assigning and assessing engineering lab reports in their major courses, while each was also an active writer in engineering disciplines (either electrical engineering and mechanical engineering). During the assessment, the fundamentals of a rhetorical approach to sound writing assessment instruments were introduced by a writing expert from the institution's writing assessment office. A writing transfer-focused rubric (see Appendix) informed by the Writing Program Administrators (WPA) outcomes (Council of Writing Program Administrators, 2014) was developed with the guidance of a nationally recognized expert on writing assessment. Prior to direct assessment, an extended norming session was provided. During the session, raters were extensively trained to evaluate student writing artifacts with this rubric focused on rhetorical features. This norming process included assessment of anchor essay packets (including one FYC research essay and one engineering lab report) via assessment with the co-constructed rubric. For the norming session, after each individual scored the sample anchor essays, the writing assessment expert facilitated discussion of these scores and interpretations of the rubric criteria. This process led to shared agreement across engineering and English faculty on the rubric criteria.

Out of 233 JWPs submitted from 2011 to 2014, a sample of seventeen engineering students' JWPs was chosen for direct assessment. The seventeen JWPs were selected for the assessment because they contained written artifacts from both FYC courses (research papers as a genre) and sophomore/junior-level engineering courses (lab reports as a genre). In addition, the students who authored those JWPs had signed a consent form allowing their portfolio to be used as research data. Because students report both the course title and semester within which they completed the course, we were able to select for writing sample artifacts completed by students who took their engineering lab courses. FYC samples were selected to include only research essays, while engineering samples were mostly laboratory reports from engineering laboratory courses. The raters (the group of four engineering faculty and two engineering graduate teaching assistants) assessed a total of 51 writing artifacts from 17 student submissions in the sample (n=17) according to five broad rhetorical categories: invention and development (the development of ideas with respect to support), conventions of disciplinary knowledge (use of subject knowledge and specialized knowledge), delivery (audience awareness), arrangement (logical sequence and design), and style (control of documentation). We also added a holistic assessment ranking.

All writing samples were rated independently by multiple raters (typically two). The extended norming session, using anchor essays to calibrate scoring of criteria, established both inter-rater and intra-rater reliability among participating engineering faculty and graduate teaching assistants. The rubric included five rankings: one for the lowest and five for the highest. Reliability was established via multiple independent scoring and subsequent rater discussion of disparate ratings if necessary (White, 1984. If there was a disparity of more than two points per any one category listed on the rubric, both raters met to discuss and jointly rerank the criteria together. The following percentages suggest the effectiveness of the extended norming session in establishing inter-rater reliability: 82% were within the acceptable 0-1 point difference margin: 41% at exact agreement and 41% within a one-point difference between two raters. This result indicates that the norming process during the workshop was conducted successfully and that the reproducibility of scoring among raters was sound.

Direct Assessment: Genre Analysis

Another direct assessment, genre analysis, was conducted on a representative subset of the original seventeen JWPs analyzed in this study. To illustrate what we identify as points of writing transfer, this subset of texts was coded manually for the following transfer goals: a sense of purpose, awareness of audience, use of rhetorical strategies and appropriate appeals, as well as an understanding of genre conventions. This analysis was performed by comparing textual evidence of these transfer goals from each student's writing artifacts between their FYC essay and their engineering lab report as contained within their JWP.

Indirect Assessment: Focus Group

In order to solicit more specific details from engineering students on their perspectives about the transfer of writing knowledge and skills, we conducted a focus group in the academic year of 2015-2016. The group of junior engineering students participating in the focus group had just completed JWP submissions, though students were not required to share their JWP for the study in order to participate in the focus group. The students selected to participate in the focus group represented the diversity of students enrolled in our engineering programs: two women and six men. Of the participating male students, there was one student of color, one international student, and one older, returning student. The focus group was conducted by a writing expert from the institution's writing assessment office (an English faculty member) from outside of the institution's engineering programs. The focus group questions were not given to the participants beforehand.

Results

Longitudinal Progress

We assembled the scores of student artifacts in 100, 200, and 300 level courses, which are mostly designed for and offered to freshmen, sophomore, and juniors, respectively, to examine engineering students' longitudinal progress. As noted earlier, the most common 100-level courses included in JWPs are from English 101 (Introductory Writing) or an equivalent from a local community college. The most common 200-level courses are from ECE 214 (Design of Logic Circuits) and ECE 234 (Microprocessor Systems), which are electrical engineering program's sophomore lab courses at our institution. The most common 300-level courses are from ECE 324 (Digital Systems Design), Mech 309 (Engineering Materials), and Mech 310 (Design and Manufacturing), all of which are courses requiring laboratory reports. Therefore, the genre of most engineering writing samples is an engineering laboratory report. As discussed previously, we were able to select for student samples wherein FYC courses were taken prior to engineering courses, as course enrollment was identified by semester on JWP submission cover sheets.

Table 1: Average scores (standard deviation) of 100, 200, and 300 level courses (rubric max score = 5, min score = 1).

	Holistic	Invention	Disciplinary knowledge	Audience awareness	Arrangement	Style
100 level	4.1 (0.8)	4.0 (0.9)	4.3 (0.8)	4.2 (0.8)	3.8 (1.0)	3.9 (0.9)
200 level	4.1 (0.7)	4.5 (0.5)	4.5 (0.9)	4.1 (0.9)	4.2 (0.9)	3.7 (1.0)
300 level	4.3 (0.9)	4.5 (0.6)	4.7 (0.9)	4.1 (0.9)	4.2 (1.0)	3.8 (0.9)

As shown in Table 1, a majority of average scores are near or exceed 4 or "very good". Note that the raters agreed the score of 4 is considered as "satisfactory" quality of writing in college-level courses. Therefore, students' writing artifacts in JWPs are overall satisfactory or higher in terms of quality. In addition, there is a clear upward trend with respect to the categories of invention, conventions of disciplinary knowledge, and arrangement. This trend suggests that engineering students' writing skills in those categories improved over the years. However, scores also show a relatively consistent or declining trend with respect to audience awareness and style, which suggests that students might struggle to improve in these areas over time. Specifically, style is the only measure wherein the average score did not exceed 4 or "very good". This result might be due to the fact that style is very much discipline-specific. Indeed, students rarely used graphics and tables with numeric values extensively in FYC writing assignments, while they are required to present arguments using discipline-specific formatted graphs and tables in engineering reports. This observation suggests that perhaps distinctions in genre conventions, in particular, can complicate students' transfer of writing knowledge from one discipline (English) to another (engineering in this case), particularly in cases of far transfer.

Writing Transfer Characterization

We conducted genre analysis to complement the quantitative data illustrated above. In developing this analysis, we relied on the prior knowledge contexts identified in *Writing Across Contexts* by Yancey et al. (2014 as our framework. They delineate three types of prior knowledge: remix (an integrated use of prior knowledge in a new writing context), assemblage (an uneven use of prior knowledge within a new writing

context), and critical incidents (where students minimally succeed or fail in a new writing task with a new writing context) (112-126). While Yancey et al. identify remix, assemblage, and critical incident as types or models of prior knowledge activity, for the purposes of our analysis, we refer to them as transfer processes. We used this typology of prior knowledge in writing transfer (remix, assemblage, and critical incident) to classify the student samples into four groups with classifications of A, B, C, and D. Details of each group's quantitative results in writing transfer characterization follows, along with qualitative analysis of select writing samples.

Group A: The Remix Group

Table 2 shows the quantitative results of the students' writing assignments from both FYC courses and engineering major courses for Group A (n=9). We categorized this group as the remix group based upon our quantitative and qualitative data analyses. Yancey et al. (2014) define remix as the integration and synthesis of new knowledge and old knowledge that generates "new understandings of composing that may change over time" (pp. 119-120). In instances of remix, students demonstrate an ability to integrate new knowledge (in this case, knowledge about writing engineering lab reports) into the schema of the old knowledge (in this case, knowledge from writing research papers in FYC). For our analysis, we identified student writing artifacts that demonstrated successful adaptation to the new disciplinary writing context and genre expectations as products of remix transfer.

Table 2: The average scores of students' reports in Group A or the remix group (rubric max score = 5, min score = 1).

Group A or the remix group (n=9)						
Courses	Holistic	Invention	Discipline knowledge	Audience awareness	Arrange-ment	Style
FYC	4.5	4.4	4.4	4.5	4.4	3.9
Engineering majors	4.7	4.7	4.5	4.4	4.6	4.1

For this group, the grand average scores or the average of the averages of six categories are higher than 4.0 or "very good" on both first-year writing (4.3) and engineering major course assignments (4.5). In Table 2, the average scores of all categories are higher than 4.0, except the average score of style (3.9) from the FYC writing artifacts. In addition, the average scores improved slightly in all categories except for the audience awareness, which has only a difference of less than 0.1. These quantitative results indicate that this group of students' transfer of writing knowledge from one discipline to another was more or less effective in its adaption from composing FYC assignments to composing engineering reports in the major.

In his JWP, Victor (pseudonym), a representative of this remix transfer process, includes an FYC research paper on U.S. economic crises and a mechanical engineering lab report on polymers and polymerization. In his FYC research paper, Victor demonstrates an ability to adapt to the genre, audience, and purpose of the assignment. For example, demonstrating familiarity with the general academic research genre, he includes an introduction that provides historical context by comparing the Great Depression to the Great Recession, then moves to a clearly define an arguable claim in his thesis statement (the need for better historical understanding in addressing current crises). He incorporates both qualitative and quantitative evidence from secondary sources to support his analysis, as demonstrated in the following quotation:

> Why should we punish them for that? The American Small Business League notes that small business make up 90 percent of all U.S. firms and create 97 percent of all new jobs (Parker 1). The

> total tax rate would go from 35 percent to 39.6 percent and the top capital gains tax would increase to 20 percent from 15 percent because of this plan (1). These statistics go to show just how important small businesses are and how crucial they are to the success of our economy.

In addition to the use of an effective rhetorical question above, this excerpt includes logical reasoning, such as establishing cause/effect relationships and analysis of statistical information. Furthermore, Victor's use of transitions, active voice, and complex sentence structure throughout his paper demonstrates audience awareness and effective style.

His adaptability to the engineering context, audience, and purpose is evident in his junior-level mechanical engineering lab report. The lab report's introduction demonstrates genre awareness by presenting the technical background and introducing the lab activities in order to provide context. Most importantly, the introduction includes the objective statement for the lab report. He illustrates an understanding of the lab report purpose through an appropriate description of primary sources (lab data) and sophisticated analysis of quantitative evidence in both text and graphics:

> Graph 1 shows the process of polymerization over time and four different temperatures. The blue area represents the liquid phase, the red represents the gel phase, and the green represents the solid phase. For example, the data taken for the 5 degree C test shows that for about 165 seconds, the mixture of the pre-polymer and curing agent was in a liquid form. Then between 165-195 seconds, the mixture was a gel.

Also as evidenced from this excerpt, he demonstrates audience awareness through the use of a neutral tone and voice throughout the lab.

Furthermore, he consistently establishes cause/effect relationships to interpret the lab data using engineering knowledge from the secondary sources, as demonstrated here: "The curing acts as an initiator for the reaction between the monomer units in the pre-polymer. The reason the plastic solid formed sooner at high temperatures is that energy is being added to the system, causing the reaction to proceed faster than at lower temperatures." Overall, his lab report is well structured through a logical progression of technical concepts (he begins with simple ideas and ends with very sophisticated technical ideas). Collectively, therefore, these writing artifacts demonstrate that Victor both developed and adapted his writing skills as he moved from composing a research paper for a general audience in the 100-level FYC course to composing lab reports for an engineering audience in the upper-division courses. As such, his writing artifacts illustrate a level of transfer occurring from 100-level coursework into the major, representative of the kind of transfer skills that occurred in the remix group.

Group B: The Assemblage Group

The average scores with the standard deviation values of Group B are presented in Table 3. We classify this group as the assemblage group due to the lack of transformation of their prior writing knowledge to new tasks as well as the constrained comprehension of lab report writing expectations. As Yancey et al. (2014) explain, assemblage occurs when students over-rely on their prior concepts of writing, which results in a strategy where they "graft" bits and pieces of new learning about writing onto that prior knowledge (p. 112). In this instance of students' use of prior knowledge, new writing knowledge is often added on to: not integrated, but rather adjoined and attached without substantially altering or refining prior concepts of writing and writing tasks.

Table 3: The average scores of students' reports in Group B (rubric max score = 5, min score = 1).

Group B or the assemblage group (n=3)

Courses	Holistic	Invention	Discipline knowledge	Audience awareness	Arrange-ment	Style
FYC	3.8	3.7	4.3	3.8	3.5	3.8
Engineering majors	4.1	4.5	4.5	4.3	3.9	4.1

With respect to our study, this group shows a slight improvement in the grand average scores from the FYC courses (3.8) to the engineering major courses (4.2). However, the range of the average scores in this group is wide (from 3.5 to 4.5) across the categories, while the standard deviation values also vary from 0.52 to 1.07. This data indicates that the raters observed significant strengths but also areas for further improvement in the students' adjustment to engineering writing. This mixture of productive and unproductive transfer from general FYC courses to engineering major courses is exhibited by the work of another student, Micah (pseudonym), which is representative of the above results.

Micah's JWP, which includes a research paper from FYC and two lab reports from two junior-level mechanical engineering courses, illustrates an instance of assemblage. In the FYC research paper, Micah's writing demonstrates a capable understanding of the writing task and FYC research paper genre expectations. For example, in his paper titled "The Future Should Be Now," he clearly articulates a standpoint on the issue (the pros and cons of technology in the knowledge economy) by positioning his view as one in opposition to a well-known commentator on the issue. Micah declares that "Carr's logic, as well written and intelligent as it may seem, is flawed, misdirected, and under researched" (1), then goes on to elaborate his own position: "when viewed from a less closed minded perspective an internet, stated simply, is the sharing of information through the use of technology" (2). As such, Micah's research paper demonstrates a solid grasp of invention, including some evidence of critical thinking, and disciplinary conventions (how to construct an argument) in the context of FYC disciplinary expectations.

Furthermore, the research paper demonstrates an adequate range of other rhetorical strategies, organization, audience awareness, style, and conventions appropriate for this writing task. For example, Micah employs questions as a rhetorical device to transition from one point to another. From the two quotes above, too, we can see that his control of sentence-level conventions is adequate but a bit limited in flexibility: on the one hand, he demonstrates an understanding of complex sentence structures for idea building. On the other hand, his control of punctuation and syntax is somewhat uneven throughout the paper.

The process of assemblage best describes Micah's application of prior writing knowledge to the engineering lab report he wrote during his first semester taking engineering courses. In his lab reports, Micah demonstrates an understanding of the lab subjects and specialized concepts. He also demonstrates familiarity with a general organization structure, including an abstract, an introduction, a conclusion, sections, and subsections as appropriate. In developing his analysis, he anticipates the audiences' expectations and needs with descriptions of processes (a bulleted list that demonstrates the "Injection Molding Process" in one lab report) and necessary discussion of analyses, such as his detailed evaluation of two possible interpretations of results in the same report. In doing so, he includes graphics and figures that are labeled and embedded within the text.

However, Micah's overall organization and arrangement over-rely on the strategies he employed in FYC, illustrating a five-paragraph essay approach, which inhibits in-depth analysis. For example, he writes,

> while we believe the material presented here is accurate, there are some issues with the data that should be addressed. First, the manual operation of the injection molding machine proved to be rather difficult to get the hand of. Many parts were scrapped due to inaccurate timing by the operator or manager, and the parts that were kept are only accurate up to human error.

While he moves to establish a claim and elaborate with evidence, his control of organization, syntax, and style are uneven. Consequently, his overall structure, flow, layout, and design are not as useful as they could be for presenting technical information.

Group C and D: The Critical Incident Groups

The last type of transfer process that we discuss is critical incident. Critical incident occurs, according to Yancey, Robertson, and Taczak (2014), when writing transfer is minimally or not at all successful (p. 120). As a process, critical incident can be described as a misfit between prior knowledge and new writing tasks that results most immediately in failure to effectively adapt to the new writing context and expectations (p. 122). Out of 17 engineering students in the sample, five students, or approximately 30% of the sample results, fit into this critical incident category. In this cohort, the average lab report scores less than 4.0 or "very good", which the raters considered as the minimum average score of high-quality lab reports. Of note, this percentage is quite close to the percent (nearly 20%) of engineering students who received a "needs work" requirement from the institution's JWP assessment results (referenced previously).

Table 4 shows that this group of students failed to meet the overall expectations of the new writing task (engineering lab report writing) successfully. We divided this critical incident group into two sub-groups based upon the scores received for the FYC writing artifacts. Group C students demonstrated consistently low grand average scores for both FYC writing assignments (3.3) and lab reports (3.9), while a relatively high grand average score (4.3) in FYC writing assignments is observed for Group D.

Table 4: The average scores of the critical incident group students' reports in Group C and Group D (rubric max score = 5, min score = 1).

Group C or the critical incident group (n=3)						
Courses	Holistic	Invention	Discipline knowledge	Audience awareness	Arrange-ment	Style
FYC	3.3	3.0	3.5	3.5	2.8	4.0
Engineering majors	3.7	4.2	4.5	3.8	3.7	3.5
Group D or the critical incident group (n=2)						
Courses	Holistic	Invention	Discipline knowledge	Audience awareness	Arrange-ment	Style
FYC	4.3	4.5	4.8	4.5	3.8	4.3
Engineering majors	3.3	3.5	4.2	3.2	3.0	2.7

As shown in Table 4, the average scores of the Group C students are less than 4.0 across all categories in the FYC writing samples, except for style. These scores suggest that this group of students struggle in multiple aspects of rhetorical principles. Although this group's average scores are maintained below 4.0 scores in the artifacts from both FYC and engineering major courses, the data suggests some incremental improvement. Except for the style category, all of the scores demonstrate improvement in the engineering major assignments. For example, the average scores of invention and arrangement improve by 39% and 29%, respectively. Of note, however, the students in this group still struggle with style in engineering assignments.

Michael's (pseudonym) JWP is representative of this first critical incident group, where students' overreliance on writing knowledge prior to college-level coursework resulted in a failure to succeed in both FYC and upper-division engineering courses. Michael's FYC research paper and engineering lab report both demonstrate little understanding of arrangement and invention in either genre. There is no improvement in arrangement from the FYC research paper to the lab report, and style is also limited and/or lacking in consistent control in both writing artifacts.

Furthermore, both writing samples are underdeveloped, demonstrate minimal use of sources, and lack sustained analysis. In his FYC research paper, for example, Michael's use of support often relies on additional claims rather than sufficient evidence, as demonstrated in this quotation:

> So how long is too long when it comes to gaming? There is no exact amount of time that works for everyone. It varies for each person, family and day. However, there are warining [sic] signs that one can look out for and be aware of. For example, if a player's eyes are blood short [sic] there is a good chance they have been playing too long to the point it is running his eyesight."

This pattern of underdeveloped evidence is also demonstrated in his lab report. In this the following example, the necessary technical information is lacking:

> My calculated grain size number was reasonably close to the ASTM grain size numbers given in the appendix. From my Rockwell test data, it is easy to see that the sample with the higher grain size number is harder than on [sic] with a smaller grain size number. Since recovery reduces dislocation density and recovery creates new strain-free grains, the hardness of the samples that undergo either should be softer.

In the lab report, the information he does use to support his claim is incorrect (recovery does not create new strain-free grains). Furthermore, he claims that his calculated grain size was close to the standardized number, but he fails to disclose the statistical data and percentage as evidence, an important convention in engineering discourse.

In Group D, the average scores from engineering major writing assignments are lower than those from the writing artifacts of first-year writing courses, as shown in Table 4. It is important to note that their average score drop in audience awareness is significant (1.3 out of 5.0 or 29% when compared with those from first-year writing courses). This drop suggests that this group had difficulty clearly identifying the technical audience's expectations in engineering courses, while they did appear to understand the rhetorical approach instructed in first-year writing courses. Another significant drop in style (1.5 out of 5.0 or 38% decline) also supports evidence of this group's challenge in transforming their knowledge of genre styles in first-year writing assignments into engineering literacies. Raters' comments also support these overall difficulties in the engineering assignments.

The JWP from Jeffrey (pseudonym) is representative of JWP writing artifacts that demonstrate these patterns in writing transfer. This type of critical incident is best described as having difficulty negotiating and adapting to a different genre and rhetorical context. In these instances, students misapply rhetorical knowledge developed in one context when writing in a new context, rather than adapting their writing performance to the appropriate rhetorical features and genre conventions of the new context. Consequently, a generalization of writing transfer occurs inconsistently and often unsuccessfully. For example, Jeffrey includes two engineering lab reports in his JWP. Both lab reports are from 300-level upper division mechanical engineering courses. In both lab reports, Jeffrey's writing skills demonstrate an adequate grasp of the engineering content needed to perform the lab experiments, while at the same time demonstrating difficulty with articulating this knowledge in the lab report format and conventions.

His difficulty in adapting the lab report genre is illustrated in the following excerpt:

> After finishing the tensile test we had hundreds of data points to sift through for each material. This was by far the most time consuming [sic] part of the lab. Using the data to make the stress-strain

> graphs gave us the change to find yield and ultimate tensile strength, %elongation, %reduction of area, and Young's modulus. These values for each material are expressed in the results section. A conclusion that can be made when looking at the data is that the materials are ductile. Brittle is thrown out as property because each material has a high plastic deformation.

In this case, an engineering audience does not expect to read an evaluation of how much the writer spent: "by far the most time consuming [sic] part of the lab." At the same time, the text does not deliver the necessary technical information. Also, his last sentence illustrates a misunderstanding of content and concepts, as "brittle" is not a property but a characteristic. As such, this excerpt demonstrates the student's grappling with both the content and the genre conventions.

Jeffrey's JWP illustrates a lack of genre awareness and purpose in that the lab report is populated with certain types of information, such as visuals and summary, but lacking in organization, analysis, and audience awareness. He consistently uses graphs, for example, but his placement and use of graphs are rarely clear and results in audience confusion. For example, in one lab report on "Tensile Testing," he piles graphs on top of one another in one section and fails to interpret both the data displayed on the elastic portion in the graphs and the relationship among the graphs for his audience, the latter of which suggests that he might be misappropriating both genre and invention as he moves from writing assignments in the FYC to writing assignments in engineering courses. While his writing displays an awareness that visuals are an important convention in lab report writing, his use of visuals demonstrates that he struggles to understand the purpose of visuals in contributing to the development and support of ideas in lab reports. This observation suggests that he might also struggle with an understanding of the overall purpose of lab reports as a genre and how they function within the field of engineering.

In addition to grappling with such skills as genre awareness, adapting to the citation and presentation conventions of lab reports illustrates a challenge for Jeffrey. For example, in his lab reports, both in-text and end-of text citations, as well as the presentation of sections and visuals, lack consistency. Sections are not consistently or appropriately named, labeled, and formatted in his lab reports. Further, his visuals are inconsistent in labeling and are not established as stand-alone figures. Collectively, Jeffrey's JWP artifacts illustrate a critical incident in writing transfer: an inability to adapt previously successful prior writing knowledge from FYC into introductory engineering courses.

Engineering Student Focus Group

To strengthen and inform our quantitative and qualitative data from the direct assessment, we also conducted a focus group to assess engineering junior students' perspectives about writing transfer from FYC to engineering major courses in the spring term of 2016. The focus group questions were designed to elicit student perceptions of rhetorical awareness, genre awareness, and writing transfer. Focus group questions included the following:

- When did you take freshmen general education writing course(s) and where? What kinds of papers (genres) did you write in that class?
- What kind of academic writing and research skills did you learn about and/or practice in freshmen general education writing course(s)?
- What do you see as the connections between the writing you did in freshmen general education writing course(s) and the writing you are doing for engineering reports?
- What do you understand the genre features of the engineering report to be?
- What genre features of the engineering report have you improved upon?

- What do you see as the differences between the writing you did in FYC and the writing you are doing for engineering reports?

Most students reported that they had taken FYC at our own institution or at a local two-year institution. For the most part, students in the focus group reported similar experiences in their FYC courses. Common types of assignment genres completed in the 100-level course were described as rhetorical analyses, arguments (persuasive writing), and research papers. Skills commonly noted across the genres included developing an argument, selecting and evaluating sources, using sources to build an argument, and practicing citation (MLA and/or APA).

When asked about their understanding of the genres they experienced in engineering major courses, students mostly discussed lab reports. With respect to the genre features of engineering lab reports, students emphasized both the use and credibility of sources, as well as the importance of tables and figures to display data and results from the experiments during the labs. In particular, students felt that they had overall improved their skills in both the selection and placement of figures and tables in lab reports. Some students also called attention to the value of data in developing analysis in lab reports to present logical arguments. Many students further expressed that they had learned the importance of doing research and using sources for evidence and support in developing their lab reports. Other genre features that students identified included understanding the purpose of introductions to provide necessary background and context, as well as the need for succinct language and third person in lab reports. Students also believed that they had improved upon being able to articulate the purpose of the lab report within the text, to make the purpose explicit rather than implicit within the text itself.

When asked about the connections that they perceived between what they learned about writing in their FYC courses and how those skills applied to the writing they were asked to do in their engineering lab reports, students noted a number of skills that transferred. In particular, they noted that writing in both courses required the following: the use of rhetorical appeals and rhetorical strategies, an understanding of the audience, the incorporation of sources, and the employment of introductions and conclusions. These are the areas that the remix and assemblage groups show improvements in lab report writing.

At the same time, students in the focus group identified a number of differences that they perceived between the kinds of writing they performed in FYC and the writing expectations with respect to both content and form (genre) for engineering lab reports. Students noted distinctions with respect to genre conventions in FYC's research papers and engineering lab reports, respectively, such as thesis vs. objectives/hypotheses, summaries vs. abstracts, and an emphasis on pathos vs. logos. These observations, perhaps, speak to the challenges demonstrated by the critical incident groups when attending to audience awareness and style in composing writing lab reports. Students also noted similarities in features but the distinction in function, such as how introductions function in each respective genre. Interestingly, students also noted marked perceptions with respect to the overall purpose of each course and genre. In general, students in the focus group understood the purpose of the FYC to emphasize writing skills/strategies vs. the purpose of engineering writing in the major courses to emphasize communicating disciplinary knowledge in engineering. In conjunction with this understanding, students characterized this distinction with the following observation: in the FYC courses, you find sources to make up your position/your argument, and in engineering, the science and/or data drives the purpose of the report.

Discussion and Conclusion

Results from our findings relate to our research questions: performance of rhetorical features by engineering students in FYC courses and/or engineering major courses; productive transfer of writing knowledge and skills by engineering students from FYC courses to engineering major courses; and perspectives on writing in FYC courses and engineering lab courses by engineering undergraduates.

Findings from the quantitative data analysis suggest that overall an upward trend exists in students' longitudinal progress (freshmen to juniors) with respect to invention and development, conventions of disciplinary knowledge, and arrangement, while there is a relatively consistent or declining trend with respect to audience awareness and style. Among all rubric categories, style was least improved from the FYC courses to engineering major courses. Arguably, style might be embedded within all or many choices a writer negotiates while composing, from subject matter to design and documentation; therefore, it is very much discipline specific. The fact that the critical incident student group demonstrated relatively lower achievements in style and audience awareness suggests a group of students who struggle to define, adapt, and address a discipline-specific audience and context. Unlike the critical incident group, the assemblage group was able to add new writing knowledge to prior writing knowledge, yet their overreliance on prior knowledge made it somewhat difficult to adapt substantively to the new audience and audience expectations. Finally, the remix group demonstrates a sophisticated understanding of audience, in part, because of their dynamic integration of new writing knowledge with prior knowledge. These observations support earlier studies that call for more attention to genre-awareness and writing transfer across institutional writing contexts and writing instruction spaces (Beaufort 2007 Ford, 2012; Yancey et al., 2014).

Data from focus groups suggests that students' general perspectives on writing illustrate a somewhat reductive understanding of the purposes of writing in FYC (English) and engineering, for example, defining the purpose of writing in FYC *only as* supporting an argument and the purpose in engineering *only as* reporting facts, as noted above. Therefore, we suggest that cuing for transfer in both FYC courses and writing-in-the-major courses might enhance the processes of understanding and adapting rhetorical knowledge and genre awareness within engineering writing-in-the-major courses. Explicit instruction in FYC that focuses on developing a meta-awareness of the genre, and the use of key rhetorical terms (i.e., audience, purpose, genre, conventions) in engineering lab report assignment guidelines, for example, can enhance writing transfer and adaptation to new genres for students, especially in cases of far transfer (Kim & Olson, 2020). Focus group responses suggested that the engineering instructors' reinforcement of rhetorical terms such as evidence, claims, or sources (introduced in FYC) improved students' understanding of lab reports as a distinct genre with genre-specific features. Focus group responses indicated an awareness of how writing skills (such as rhetorical knowledge, audience awareness, and conventions) might carry over from one writing context to another while also needing to be adapted in a different context. Responses also suggested that students developed an understanding that genre features are genre specific and informed by disciplinary contexts.

Our study suggests that JWPs are useful tools to investigate students' transfer in writing because they contain both first-year general education writing artifacts and upper-division engineering laboratory reports, a collection of writing samples that affords the possibility for investigating writing transfer from both a far transfer and longitudinal perspective. While WAC assessment models like the JWP at WSU are not as common across many higher education institutions, similar institutionally-situated approaches for collecting and studying student writing artifacts across disciplines might be embedded within other established or burgeoning WAC programs and/or required writing-intensive courses across majors or disciplines. Doing so, as our research suggests, can provide necessary and welcome opportunities for professional development in writing pedagogy for disciplinary faculty to improve students' writing instruction experience within majors.

In the case of our study, it proved a useful professional development experience for engineering instructors and teaching assistants unfamiliar with common FYC genres (research-focused essay or argument, for example) and terms used in a rhetorical approach to teaching writing, providing them with the opportunity to learn how writing experts address academic writing. During the three-day assessment session, for example, engineering laboratory instructors began to classify the genre of their writing assignments as lab report, memorandum, technical report, or research paper. They also recognized the importance of articulating the audience's expectations in their lab handouts through describing the purpose and the

context of each lab report assignment. They agreed that the technical contents could be strengthened in writing assignments when the assignment made explicit for students the genre and rhetorical situation (writer, audience, purpose, and context). Providing solid rubrics for assessment is also a key factor to enhance engineering students' writing performance. Many participating engineering instructors updated their lab report assessment rubrics by using key terms, such as audience, purpose, argument, organization, etc., which engineering students were already familiar with from their FYC courses.

Likewise, English faculty benefited by learning from engineering colleagues about the role, conventions, and value of lab report writing from the perspective of disciplinary experts, which informed FYC instruction. While engineering faculty updated their rubrics to reflect FYC writing terms, English faculty updated their curriculum to include more coverage of and occasions for including both primary research and quantitative evidence. As Ford (2012) notes from her experience as a joint faculty member in technical communication and engineering, the opportunity to reinforce rhetorical instruction within engineering courses can provide effective writing support for engineering undergraduate students. Our research suggests that a better understanding of the prior knowledge that students carry with them from FYC courses into writing in the major courses in engineering might assist engineering faculty in facilitating writing transfer and student success within their laboratory courses.

This exploratory study of far transfer investigated how transfer occurs across the curricula, as well as how transfer occurs between seemingly different writing contexts: the far transfer of writing skills from FYC classes to upper-division engineering classes in the major. In doing so, we acknowledge the challenges in studying and measuring writing transfer, including the complexity in accounting for prior knowledge across multiple contexts and the often-constrained representations of student learning and writing in methodological approaches (Hendricks, 2018). Limitations of this study include the small sample size and the self-selection of the student population, including only those students who agreed to allow their writing artifacts to be used for research. Due to the small sample size, we were unable to disaggregate data or yield meaningful results regarding student demographics. Additional uncontrolled variables include students' backgrounds and learning environments, as well as course delivery of FYC and engineering labs (course content and instructor variability).

That said, by using prior knowledge processes as a framework for investigating the transfer of writing features, we discovered that while some automatic transfer occurs, some engineering students still struggled in multiples areas, specifically with respect to rhetorical awareness and genre conventions. Given that a number of engineering students in our study struggled with far transfer, as our findings suggest, we propose that a writing pedagogy focusing on rhetorical knowledge and genre awareness in engineering laboratory courses might better cue for writing transfer by reinforcing the rhetorical foundation of writing skills that students often experience prior to their engineering lab courses. While acknowledging the possibility for multiple approaches to support facilitating transfer across courses and disciplines, we suggest this approach particularly in the cases of engineering lab report courses because they represent instances of both writing in the discipline courses and far transfer, wherein students are often asked to engage in new and less familiar genres. And as noted above, such an approach has the added benefit of providing professional development in writing pedagogy to support engineering faculty and teaching assistants who teach writing in the major courses. So as to better understand the usefulness of a writing transfer approach focusing on genre and rhetorical knowledge, future studies might compare the benefits of this approach alongside other approaches, such as an emphasis on meta-cognitive strategies, which is also a popular approach in FYC courses in the United States.

Given their emphasis on past learning experiences, transfer learning theories provide a useful theoretical framework for better understanding the writing experiences of undergraduate students as they adapt to the contexts and expectations of writing within their majors. Writing transfer, as an act of ideological and rhetorical repurposing by students, requires a more intricate appreciation of the rhetorical situations, knowledge, and systems that students must navigate as they move from discipline to discipline (see Beaufort

2007, Nowacek 2011, Wardle 2012, and others). As Beaufort and others suggest, interdisciplinary and longitudinal studies of writing transfer promise to further develop our knowledge and understanding of both how students come to adapt and develop writing skills across contexts and how those processes are complicated and enriched by a multitude of influences.

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Appendix

Table A- 1:Rubrics used for the program-level evaluation process

Score	5	4	3	2	1
	Excellent (A to A-)	**Very Good (B+ to B)**	**Good (B- to C+)**	**Fair (C to C-)**	**Weak (D to F)**
Holistic Assessment	It has substantial content and clear organization and focus. It presents ideas clearly and even gracefully.	The strengths outweigh its weaknesses. It has solid development and is clearly organized and focused, but it is not as strong as an "excellent" portfolio.	The strengths of the portfolio outweigh the weaknesses, but the development of ideas is not complete, the organization and focus are not clear, and the language is not strong.	The strengths and weaknesses are about equally balanced. The writer has tried to develop ideas, focus the paper, and use effective language, but parts are underdeveloped, disorganized, or confusing. The writing may be too general or predictable.	The weaknesses outweigh the strengths. The portfolio is weak, underdeveloped, poorly focused, and too general. However, errors could be minimal.
Invention and Development	Sophisticated development of central idea, purpose, evidence and support	Solid and consistent development of central idea, purpose, evidence and support	Adequate development of central idea, purpose, evidence and support	Uneven development of central idea, purpose, evidence and support	Incomplete and/or underdeveloped central idea, purpose, evidence and support

Conventions of Discipline Knowledge	Shows sophisticated understanding of the subject and high degree of facility with specialized concepts	Shows clear understanding of the subject and facility with specialized concepts	Shows some knowledge of the subject or use of specialized concepts	Shows inconsistent knowledge of the subject or use of specialized concepts	Provides little or no evidence of knowledge of the subject or use of specialized concepts
Audience Awareness	Sophisticated use of disciplinary appropriate genre, format, language, tone, and audience awareness	Solid and consistent use of genre, format, language, and tone appropriate to the discipline and audience	Use of genre, format, language, and tone are appropriate to the discipline and audience, but not highly developed	Shows limited use of genre, format, language, and tone are inappropriate to the discipline and audience	Use of genre, format, language, and tone are inappropriate to the discipline and audience
Arrangement and Layout	Successfully develops ideas in a sophisticated logical sequence and design choice	Successfully develops ideas in a logical sequence and appropriate design choice	Adequately develops ideas in a logical sequence and appropriate design choice	Shows difficulty in presenting ideas in logically and with an appropriate design choice	Shows limited understanding of organization and visual design
Knowledge of Writing Conventions and Style	Sophisticated control of documentation, mechanics, and style	Solid and consistent control of documentation, mechanics, and style	Adequate control of documentation, mechanics, and style	Uneven control of documentation, mechanics, and style	Limited and/or lacking control of documentation, mechanics, and style

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