EFFECTS OF FIRST-YEAR INTEGRATED WRITING AND DESIGN CURRICULUM ON WRITING ACHIEVEMENTS of ENGINEERING STUDENTS: RESULTS OF A TWO-YEAR ASSESSMENT STUDY

Suzan Last
Department of English
University of Victoria
sulast@uvic.ca

Peter Wild
Department of Mechanical
Engineering
University of Victoria
pwild@uvic.ca

Geri Van Gyn
Faculty of Education
University of Victoria
gvangyn@uvic.ca

Abstract – *This paper presents the results of a two year assessment study (2010-2012) that compares the writing outcomes of engineering students who completed a newly designed integrated first year Communications and Design course (ENGR 110) to the achievements of Engineering students who had taken the traditional first year composition course previously offered to engineering students. The purpose of the study was to determine if the new course design, with its emphasis on engineering-specific reading and writing content, as well as written assignments based on students' design lab activities, enhanced students' achievement of writing skills. The results show moderate to significant improvement in all but one of the assessed skills, indicating that the new integrated course design has been successful in achieving its goals.*

Keywords: *Integrated Course, Curriculum, First-year, Learning objectives, Design, Communications, Writing, Assessment study.*

1. BACKGROUND TO THE STUDY

In 2009, the Engineering and English departments at the University of Victoria collaborated to design a new course for first year engineering students that integrated curricula from the First Year Writing Requirement (Academic Writing) with Introductory Design (Mechanical, Electrical, Computer, and Software engineering). One purpose of this integrated course was to offer the required Academic Writing course in a more discipline-specific manner (Engineering Communication), to improve engagement and achievement in the writing activities. Current research with a similar goal [1] found that a discipline-based learning environment produced better report writing. This supports Hyland's [2] statement that "writers galvanise support, express collegiality, resolve difficulties, and negotiate disagreement through patterns of rhetorical choices which connect their texts with their disciplines. Most simply,

physicists don't write like philosophers nor lawyers like applied linguists. Writers have to establish a professionally acceptable voice and an appropriate attitude, both to their readers and to their arguments, and the analysis of genres helps to show how disciplines create a view of the world through their genre conventions" [2; p. 549).

Making the writing course more discipline-specific encourages the students to perceive writing and communications tasks as an integral part of their professional development and learning, rather than as a largely irrelevant academic hurdle to be overcome.

Another goal was to introduce hands-on design experience (Engineering Design) in the first year of the Engineering program – a program otherwise heavy with theoretical math and physics – with the aim of increasing student engagement and retention.

To achieve these two goals simultaneously, a 1.0 credit Design Lab taught by Engineering instructors was merged with a 1.5 credit Academic Writing course taught by English instructors to create ENGR 110: Design and Communication I. In the Design Lab, students were introduced to basic engineering concepts and practice. They worked in teams to complete several small design challenges and one large design project. The labs and accompanying lectures and readings emphasized teamwork skills and the design process.

The Communications portion of the course introduced students to the forms and conventions of academic writing, specifically in the field of engineering, and assigned readings and writing topics related to their design challenges, team work, and the design process in general. The teaching team met regularly to ensure an integration of content and learning objectives throughout the term. At the end of each of the first 3 offerings of the course, students were invited to participate in a study that compared their writing achievements to engineering students who had not taken the integrated Communications and Design course. A companion study also assessed their engagement with the course and retention in the program.

2. PURPOSE OF THE ASSESSMENT STUDY

This study was designed to assess the effect of the new integrated course on students' writing outcomes. The new course design was intended to increase engagement, and thus improve learning outcomes. The study compared a specific set writing achievements of students who took ENGR 110 with those of students who took the general Academic Writing course, in order to assess the effectiveness of the new integrated ENGR 110 course at improving students' writing achievements.

3. METHODOLOGY

Students who took ENGR 110 and students who took equivalent Academic Writing courses (Baseline Group) completed a diagnostic writing sample in the first week of the semester following their respective Academic Writing courses; students voluntarily allowed their diagnostic assignment to be used in the study. This study received approval from the UVic Human Research Ethics Board.

Students were asked to respond to the following writing prompt:

In a 3 paragraph mini-essay, explain which of the three phases of the writing process (pre-writing, drafting, or revising) presents the greatest challenge to you as a writer, and why. Begin with a straightforward statement of purpose (thesis), pay attention to principles of paragraph development (topic sentences, development of topic using specific examples, use of transitional words and phrases to link ideas, etc), and end with an effective final thought on ways you might deal with this challenge.

Hand in all three stages of this assignment: 1) one page of prewriting material, 2) a rough draft with your revision marks, and 3) a final revised copy of roughly 300 words.

We compared the writing samples of the ENGR 110 students to those of the Baseline group according to a set of criteria chosen to measure certain course learning objectives. The following ENGR 110 course learning objectives were taken directly from the course outline and used to develop the assessment rubric: Students will learn how to

- "Use a problem-solving approach to writing tasks"
- "Identify a specific purpose for writing" (task analysis)

- "Understand and apply the writing process for writing tasks; identify purpose, plan, outline, draft, revise, edit and proofread"
- "Write well structured sentences and paragraphs in correct standard English"
- "Identify the strengths and weaknesses in their own writing"

Each of these learning objectives were broken down into specific criteria for rating, each accompanied by a rating rubric (see Appendix for sample rating rubric). Each sample was rated on the following criteria:

- *Task Analysis*: student demonstrates understanding of the assignment, follows instructions by addressing assigned topic, and submits complete work as requested
- *Problem Solving Approach*: Student self-assesses a "writing problem" and seeks potential "solutions" to overcoming this challenge
- *Understanding and application of the writing process*: Discussion demonstrates clear understanding of the writing process; Makes use of a Prewriting strategy; writes a draft with annotated revision marks; final version shows evidence of revision and proofreading
- *Mechanics*: sentence structure, agreements (subject-verb; noun-pronoun; etc.), usage, punctuation
- *Paragraph Development*: Topic sentences define and control paragraphs; examples develop and illustrate ideas; transitional words and phrases create coherent development of ideas

In addition to quantitatively assessing achievement of learning objectives, the data offers frequency of response information on what prewriting strategies students typically use, and what areas they typically identify as most challenging or as "weaknesses" in their writing.

Data was collected from two hundred ENGR 110 students between 2010-2012. This data was compared to that taken from 65 non-ENGR 110 students from various equivalent sections over several semesters between 2009-2011 to gather comparable baseline data. These non-ENGR 110 students are referred to as the Baseline Group.

Using a double-blind method, all students' writing samples were evaluated by two raters, using the criteria above (see appendix for a sample rating rubric) using a

scale from 1-5 (5 being most proficient). When the raters' evaluations differed slightly, the results were averaged. The averaged results were entered into spreadsheets for analysis.

4. RESULTS

The following data compares the results of the ENGR 110 Groups (students who took the 2nd and 3rd offering of the new integrated Communications and Design course) to the results of Baseline group who took traditional Academic Writing course with the general student population, not with a cohort of Engineering students.

The averaged results of the ENGR Groups are compared to those of the Baseline group in the figures 2-5. Figure 1 shows the frequency of responses to the main question: which of the three stages of the writing process do you find most challenging? The five rated responses were

- A. Prewriting
- B. Drafting
- C. Revising
- D. Combined answer (student did not pick just one)
- E. None (student failed to address the question)

Fig. 1. Compared frequency of responses to the diagnostic question.

This category was not assessed on an evaluative scale; however, the frequency of responses indicates where students feel that they have the most difficulty. The majority of students in both groups (40-41%) chose prewriting as the stage they found most challenging. This is helpful to know in further refining the course. We have used the data to build in more prewriting instruction and practice into the course design.

Of the many prewriting strategies available to them, the vast majority of students (45-55%) chose to use a linear outline. The second most popular choice was freewriting (20-25%), followed by concept mapping (5-

12%). Some prewriting styles did not fall into rater categories, and 3-5% did not submit a prewriting sample.

Figure 2 compares the averaged results the ENGR cohorts (2 & 3 combined) to the Baseline group in all categories. These data show that the ENGR students scored higher than the baseline group in every category but one.

Fig. 2. Averaged results comparing Baseline and ENGR groups in all assessed categories.

The writing skills that were assessed and compared fall into three main categories:

- Macro Writing Skills:
 - Effective Task Analysis
 - Understanding and use of Writing Process
 - Use of Problem/Solution strategy
- Paragraphing Skills:
 - Effective Topic Sentences
 - Coherent transitions
 - Detailed examples to develop ideas
- Micro (Grammar and Usage) Skills
 - Correct Sentence Structure
 - Agreements (subj.-verb, noun-pronoun, etc)
 - Usage

Figures 3-5 present the results broken down into these categories, comparing the results of the Baseline group to the combined ENGR groups.

Figure 3: Averaged Results for Macro Skills Assessment comparing ENGR groups to Baseline.

The “macro” skills are deemed very important indicators of student success, as students who can perform effective and accurate task analysis have a better understanding of what the assignment entails, are more likely to recognize when they are off track and choose appropriate strategies to get back on track, and have more success.

An understanding of how to use the writing process to effectively plan, draft and revise a document similarly increases students’ achievements. Applying a problem-solution model to a writing task asks the students to apply their typical engineering problem-solving strategies to a task that they do not typically think of in this way. Professional engineering writing tasks generally require this kind of model (define the problem; describe a proposed or recommended solution).

Figure 4: Averaged Results for Paragraph Skills, comparing ENGR groups to Baseline.

In the general category of Paragraph Skills, students were assessed on their abilities to write unified and coherent paragraphs with clear, controlling topic sentences, logical transitional words and phrases to link ideas, and concrete examples to illustrate and develop their ideas. See Fig. 4 for compared results.

The “micro” skills were assessed quantitatively: the fewer the mechanical errors in a sample, the higher the score. For example, a score of 5 would be given to a sample that had 0 sentence structure errors; 1-2 errors would earn a score of 4 (see Appendix for more detailed rubrics). Fig. 5 shows the comparative results in these categories.

Figure 5: Averages Results for Micro Skills (Mechanics of sentence structure, grammar, punctuation and usage), comparing ENGR groups to Baseline group.

5. DISCUSSION

The initial results reveal that most students in all groups find prewriting to be the most challenging stage of the writing process. This stage includes the thinking out, planning, researching and outlining of documents. Knowing this can help instructors to include more prewriting information and exercises into the course design in order to help students feel more confident and capable in this area. Various methods of prewriting can also be stressed, based on which methods students find most useful. The results also show that students need further work on using a problem/solution model to approach writing assignments, and that further work on punctuation is needed.

5.1 Comparative Assessment of Macro Skills

The comparative assessments of the rated skills show that students in the integrated course produced higher scores in all but one category. The rating scale ranged from 1-5, with 1 being extremely poor, and 5 being excellent. The macro skills assessed – Task Analysis, Use and Understanding of the Writing Process, and the use of a Problem/Solution model to structure their writing – all showed improvement in the ENGR groups. The Task Analysis question rated students' ability to understand and fulfill the assignment criteria. Both the Baseline and the ENGR groups scored high in this category (4.03 and 4.22 respectively), with the ENGR group scoring ~4% higher.

The scores for understanding and making use of the Writing Process were similar (4.35 and 4.4) indicating excellent proficiency in this area for both groups. Because the integrated course stresses the concepts of design process as well as writing process, we expected a greater difference in achievement. However, this is a fairly straightforward concept, and one that is strongly emphasized in the Academic Writing courses as well.

Where the most significant gains were made was in the students' use of a Problem/Solution model to structure their response. Both groups' scores were relatively low in this category – Baseline = 3.16; ENGR = 3.54 – but the ENGR group made one of its largest gains in this category.

The fact that the average score is still only 3.54 is disappointing and means that the course should focus more on this concept to improve students' skill in applying a problem/solution approach to writing tasks. Since engineering in general takes a problem/solution approach, this should be better understood and applied by engineering students in the context of their writing tasks as well. However, the fact that the ENGR students' scores were significantly higher means that we are on the right track and making improvements in this area.

5.2 Comparative Assessment of Paragraph Skills

The ability to write a unified and coherent paragraphs, with strong, controlling topic sentences, coherent transitions from idea to idea, and the use of examples and details to develop ideas also seems to have been improved by the integrated course design, as the ENGR groups scored marginally higher in all categories. Both groups scored very well on the use of transitional words and phrases (4.16; 4.26), while both groups received moderate scores on topic sentences (3.5; 3.7), and somewhat low scores on the use of examples to develop ideas (2.86; 3.11). The ENGR groups scored 4-5% higher than the Baseline group in the Topic Sentence and Example categories, indicating that while there is still

room for improvement overall, the integrated course has led to increased achievement in these basic skills.

5.3 Comparative Assessment of Micro Skills

The assessment of the grammar and usage categories indicates that the students in the integrated ENGR course scored higher in all but one category: sentence structure. Both groups, however, got very high scores in this category, indicating that both first year courses effectively promote this skill. A score of over 4 indicates that the student had no more than 2 sentence structure errors (comma splice, run on, fragment, faulty parallel, or dangling modifier) in the final revised version of their submitted assignment. These skills are all rated quantitatively, based on the number of these types of errors appearing in the samples.

Table 1. Comparison of micro-skills scores

Micro Skills	Baseline Group	ENGR Groups
Sentence Structure	4.65	4.61
Agreements	4.73	4.75
Punctuation	3.68	3.87
Usage	4.21	4.27

The differences were small, but indicate a trend of marginal improvement in the integrated course.

6. CONCLUSION

While the sample sizes used in the study were small, the results show consistent improvement in the writing achievements of the ENGR student groups. This suggests that the new integrated Communications and Design course is an effective academic vehicle to improve first year engineers' writing skills. Designing the academic writing curriculum to be more directly relevant to engineering topics, supports Hyland's [1]-[2] contention that discipline specific writing activities produce better writing products. As well, integrating the required writing class with an exciting, hands-on design lab, has made academic writing seem more relevant and engaging to the students in the ENGR 110 class than to engineering students in a traditional first-year English course.

This quantitative evidence is corroborated by qualitative impressions of the instructors teaching the Communications portion of the course. Instructors were asked to give anecdotal evidence on their impressions of the effectiveness of the integrated course. One instructor noted that the students recognized that the course had been

“tailor-made for them, and they could see the disciplinary relevance to them of the articles chosen for the coursepack/textbook, and of the hands-on

work they did in the design component. I can remember at least a few students expressing satisfaction with ENGR 110 specifically because previous English/writing courses they had taken had concentrated on literature.... ENGR 110's integrated design and engineering-oriented readings enabled a lot of my engineering students to feel more comfortable than they had ever felt in a writing course." (Joseph Grossi)

Another instructor offered these observations:

"I think 110 students experience a stronger commitment to their composition course than regular students because they see it being actively supported by their own faculty and clearly blended with the interests and value of that faculty.... The idea that they're developing transferrable skills is more clearly evident to them than to students in a regular course.... the subject-matter is specifically relevant not only to their intended major and eventual careers, but to what they actually enjoy doing in the labs. This means they're more willing to put effort into developing the skills they're being called on to practice, and not just see the writing they do as an obstacle to doing what they want to do, which is engage with engineering." (Monika Smith)

As both the quantitative data and the qualitative observations of instructors show, the added relevance and engagement provided by the integrated communications and design course leads to a more effective learning environment for the students and improved writing achievements. Ongoing companion studies are in the process of assessing student engagement and retention in the integrated ENGR 110: Design and Communication course; preliminary results support the findings of this study.

Acknowledgements

The authors gratefully acknowledge the financial support of the Learning and Teaching Centre and the NSERC Chair in Design Engineering at the University of Victoria. The authors also wish to thank the many colleagues in the Faculty of Engineering and Department of English who have assisted us in conducting this research.

References

- [1] R.E. Burnett and J. Watts, "Pairing courses across the disciplines: Effects on writing performance," *Written Communication*, vol. 30, pp. 208-235, 2012. doi:10.1177/0741088312438525
- [2] K. Hyland, "Genre and academic writing in the disciplines," *Language Teaching*, vol. 41, pp 543-562, 2008. doi:10.1017/S0261444808005235
- [3] K. Hyland, "Writing in the disciplines: Research evidence for specificity," *Taiwan International ESP Journal*, vol. 1, no. 1, pp. 5-22, 2009.

APPENDIX: SAMPLE ASSESSMENT RUBRIC

Raters were given a detailed assessment rubric to use while assessing the students' writing samples. Table 2 provides a sample of the rubric they used to assess the categories of Sentence Structure on a 5-point scale.

Table 2. Assessment Rubric for "Sentence Structure"

5	4	3	2	1
No errors; or one very minor error that does not interfere with clarity at all.	1-2 errors, but these have minimal impact on clarity of meaning. Fragments (may be stylistic); Run-on or fused sentences imitate colloquial style; Parallel faults or dangling modifiers are minor.	3-4 SS errors have a more pronounced impact on clarity, but do not make ideas impossible to understand. Fragments make subject or verb unclear Run-ons create confusion over main idea Parallel faults make listed items unclear	Several more serious sentence structure errors make ideas difficult to understand May have to read much of this 2 or 3 times to figure out the meaning, but you can eventually figure most of it out. Some meaning remains garbled.	Every or almost every sentence contains a structural error; ideas are difficult or impossible to comprehend because of these errors (not word choice, but structural errors).