Experiential Learning and Communication: iFixit in the Technical Writing Classroom

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Abstract

Experiential learning and writing support long-term memory, pattern recognition, faster problem solving and learner confidence. Writing, too, has been shown in cognitive research to aid in achieving learning outcomes when used in targeted ways, such as in self-reflective inquiry, wherein students are asked to reflect on knowledge gaps or invited to connect old information and new. Industry stakeholders have also identified writing and communication as a key area for increased instructional attention and improvement. These research findings and industry values are further institutionalized through ABET student learning outcomes, particularly (g): "[demonstrate] an ability to communicate effectively." However, conventional technical writing courses typically focus on writing for the sake of writing, and omit most forms of experiential learning. Armed with this research and disciplinary directive, the Technical Writing and Communication course, developed to meet the needs of the School of Engineering at The Citadel, has been recently revised to allow for more situated, industry-led, experiential learning opportunities. Results indicate that experiential learning contexts, supported by industry-informed writing tasks, serves to increase students' observed and self-perceived written and verbal communication skills across a variety of contexts.

This paper reports on communicative performance differences between two Technical Writing and Communication course designs: a control course, featuring a more traditional approach to technical writing and assignments, and an experimental course, which featured an intervention whereby student teams completed an electro-mechanical device repair and documentation project. The device repair and documentation project requires students to propose and report on deliverables to corporate representatives, produce user-oriented technical prose supported by detailed photography, and proceed with the project according to their own declared timelines to deliver publish-ready user guides. At completion, these user guides are published on the site and accessed by a growing network of global users. It is hypothesized that the experiential device repair and documentation project uniquely equips students in the experimental cohort with procedural approaches to technical writing that serve as incomparable supports when they are later tasked with larger, more open-ended writing tasks.

Using quantitative and qualitative results, this paper provides evidence that experiential learning opportunities in an engineering-focused Technical Writing and Communications course is a best fit for this demographic's learning preferences and creates measurable course impacts. Longitudinal data collected from these outcomes allow for a better reading of student performance gains, and results will guide future instructional design choices.

Introduction

Technical writing pedagogy, aimed at engineering students, must feature experiential learning and writing-to-learn practices in order to best address the communicative needs identified by industry stakeholders. A natural fit for a technical writing and communication curriculum designed for the needs of engineers, the Kolb model of experiential learning features a practice that is process-based, focused on connecting new and old knowledge, and requires learner discomfort—through iterative testing a learner must be willing to dispense with ideas found to be false. Knowledge creation occurs through the meaningful interaction of one's lived experience with that of the immediate environment [1].

Understood as an active and dynamic approach to problem-solving, experiential practices in the classroom offer unique student impact opportunities for mid-performing students, while still retaining value for advanced students [2], a finding supported by this study. Engineering students overwhelmingly prefer an active approach to learning in their undergraduate years. Using the Index of Learning Styles (ILS) [3], a 44-question instrument made to reveal learning style preferences across four polarities: sensing—intuitive; visual—verbal; active—reflective; and sequential—global. Engineering students from a dozen institutions displayed a clear, consistent preference for active learning, that is, learning by doing and attempting new solutions [4].

While engineering students prefer visual rather than verbal depictions of new content [4], as Solomon and Spurlin note, learning style preferences merely provide useful self-knowledge—they are not labels that limit an individual's future abilities. Rather, educators are obligated to move students past their comfort zones [4], providing opportunities to engage strengths while addressing points of weakness. Appropriate use of the ILS instrument then entails the incorporation of verbal and written communication into the modern engineering curriculums, but writing prompts must be implemented in ways supported by cognitive science. Now empirically validated across primate studies of cognition [5], 20th century neuropsychologist Martin Hebbs' intuition that "neurons that fire together, wire together [6]," has important implications for writing-to-learn practices. When writing is used iteratively in low stakes tasks, reorganizes and elaborates on known information, and identifies knowledge gaps through self-reflection [7], [8], writing supports learning and triggers information retrieval.

Improved writing and communicative skills are widely identified as needs in industry [9], however many graduates fail to transfer communicative skills from an academic domain to a professional one, a challenge widely documented [10]. This persistent challenge is likely due to differing contexts, audiences, and writing tasks associated with each domain. To meet engineering students where they are, this study measures the learning impacts of an experiential, collaborative, corporate-led technical writing project that seeks to reproduce professional writing tasks as much as it reinforces experiential learning opportunities.

Course Background

In collaboration with faculty from the Department of English, Fine Arts, and Communications and the School of Engineering, the Technical Writing and Communication course at The Citadel was designed around project-based learning. Divided into four major projects, the course initially assessed a professional portfolio; a technical manual report and evaluation; a research brief; and an oral brief.

The initial course design featured exposure to technical manuals through usability testing and reporting. Students familiarized themselves with and assessed three technical manuals of their choosing for the following features found to be appropriate for such testing: usability;

comprehensibility; readability; and interest [11]. Assessments featured both a Likert-scale score and qualitative justification within student reports. While this project allowed students to select manuals with which they were already familiar, it also required students to adopt a user's mindset to evaluate the efficacy of prose, organization, and procedural explanations in their chosen manuals. As future Subject Matter Experts, adopting the perspective of a user allows students to anticipate the kinds of problems non-SMEs may encounter, and is a useful cautionary exercise for discussing how to organize and present content for multiple audiences.

To provide more hands-on, collaborative learning opportunities for her students, the instructor attended an educational workshop and seminar at iFixit Headquarters in San Luis Obispo, California, where she was trained in offering iFixit's technical writing and repair project. iFixit is a wiki-based site that empowers users to fix their own electromechanical devices and share their technical knowledge with the world—while also vending replacement parts and tools [12]. The non-profit arm of iFixit, iFixit EDU, coordinates a technical writing project requiring students to document simple repair procedures for older electromechanical devices, as well as cell phones, computers, and tablets. The iFixit technical writing project was implemented in two of three sections in Fall 2018 to replace the technical manual report and evaluation. One section continued with the previous curriculum's project.

The iFixit project also featured exposure to concepts like usability testing and audience awareness, but accessed the highest levels of Bloom's Taxonomy—creation. Working in groups of 3-5, depending on class size, student groups were assigned a device, toolkit, camera, and lab space to create documentation for iFixit-assigned devices, sourced from iFixit's e-waste collection and for which no preexisting documentation was available on the site.

iFixit Project Teaching Methodology

The iFixit project was organized along 5 major milestones, outlining each phase of the documentation project. Each milestone [13] was subject to review by iFixit technical writers and the instructor. The final product was evaluated by peer teams at The Citadel.

1) **Getting Started:** Provides learner content and primers in how to use site resources, creating a profile, and registering student teams. Example successful Project Proposals are detailed, and students are asked to complete a resource checklist and then send all proposals to iFixit.

2) **Milestone 1:** Provides resources for the creation of a Troubleshooting wiki for each device, with planned repair guides linked under appropriate sections. Troubleshooting wikis provide general device information, and require students to research known common repairs as well as anticipate repairs that are likely to be needed due to the normal wear of moving parts and device design choices.

3) **Milestone 2:** Provides tips for the creation of a Device page that will house all device-related information, including device general research, Troubleshooting wikis, and future Repair Guides.

4) **Milestone 3:** Provides a tutorial in the proper pairing of device photography and technical prose, such that both are semantically redundant, and either could be followed in isolation to correctly execute a repair process. Students create 5-7 Repair Guides for various device components that they identified in their Project Proposal.

5) **Milestone 4:** Provides standards for usability testing and peer review of the three resource pages described above (Troubleshooting wiki, Device page, and Repair Guides) [14].

Student Feedback and Performance

The Citadel's Technical Writing and Communication students strongly fit learning preference profile already established for engineering students nationally [4], suggesting that a procedural, applied, hands-on approach to teaching this demographic is a good fit. Figure 1 shows an exact alignment with reported learning preference profiles reported elsewhere in the literature, however it should be noted that our students' preferences for visual (92.6%) and sequential learning (72.2%) are more strongly marked.

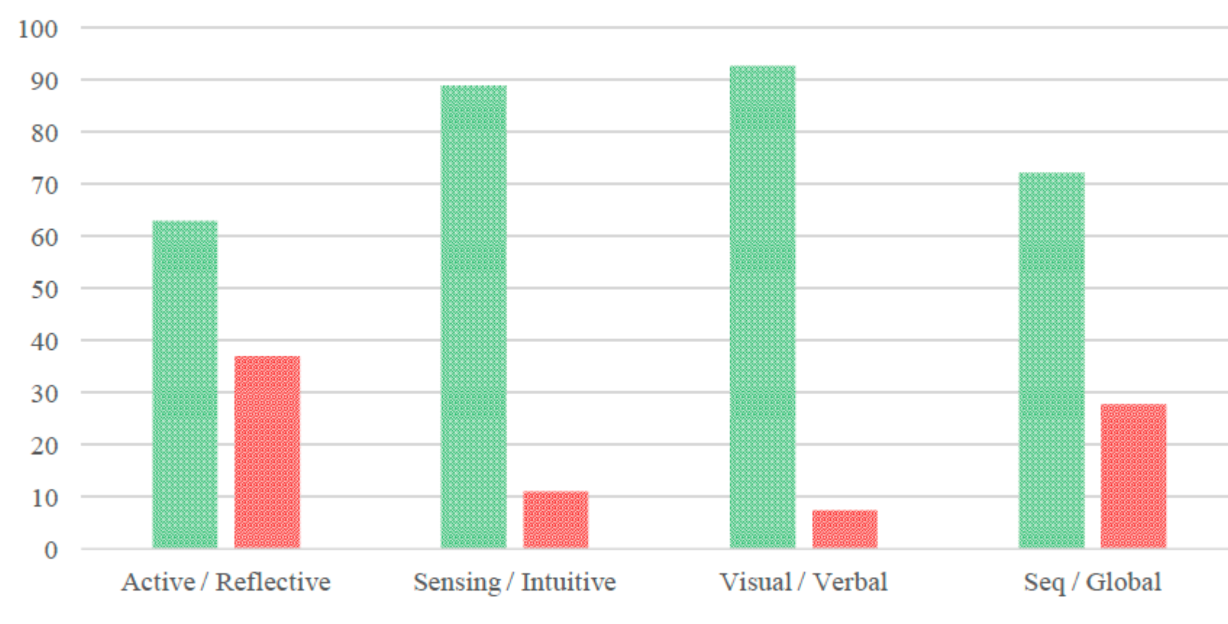

Figure 1: Students' Reported Learning Preferences at The Citadel using ILS Instrument.

Qualitative and quantitative surveys administered at the beginning, middle, and end of the iFixit Technical Documentation project indicate that students' perceptions of the project were positive. 43% of students cited professional communication as the most important thing they took from the project, an important consequence of the consistent feedback and approvals required by the iFixit technical writing team—as well as the accountability each team member had to his or her team. The remainder cited group formation dynamics and learning to adhere to strict timelines for completion as major takeaways.

In response to the question, “What recommendations for improvement would you make for this project?,” 75% of the 39 responders provided no recommendations for improvement or expressed satisfaction, with 25% relaying concerns related to the devices they were assigned for the project or similar logistical issues. Student commentary to this effect is given below:

- “I think this is one of the most valuable projects I have ever done in my college experience thus far.”
- “I believe that this project is a great way to get students involved in a relatively easy project while learning about many key communication and teamwork skills.”
- “Good project for those who have never done any technical writing. Also, a great refresher for those who have.”

That said, some concerns were raised during a subsequent survey administered near end-term. In response to the question, “Are there any other comments about your experience that you would like to share?”, some students mentioned concerns regarding the compact timelines of the iFixit project, and the desire for increased accountability among team mates for project completion.

Quantitative results show that despite significant differences in academic abilities across control and experimental technical writing sections (Prob > F, 0.0192*), students maintained performance parity after introduction to the iFixit Technical Documentation project. Figure 2 shows a significant difference in mean GPAs of incoming students to the course. For example, the section 1 cohort, the control, was already performing more effectively than was Section 2, one of the experimental sections, when these students entered the course. Meanwhile, Figure 3, shows initial disparities of ability did not affect final grades; all sections performed similarly (Prob > F, 0.6204). This suggests that experiential, collaborative work offers real benefits to struggling to intermediate-performing students in particular, a result supported in other studies [7], [8].

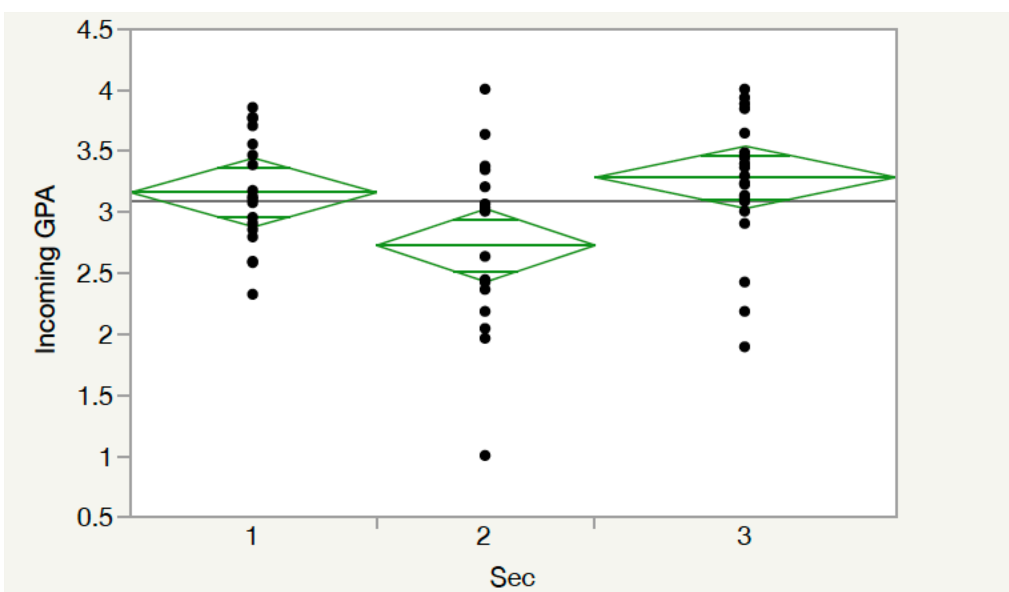

Figure 2: Means of Incoming GPAs Among Course Sections.

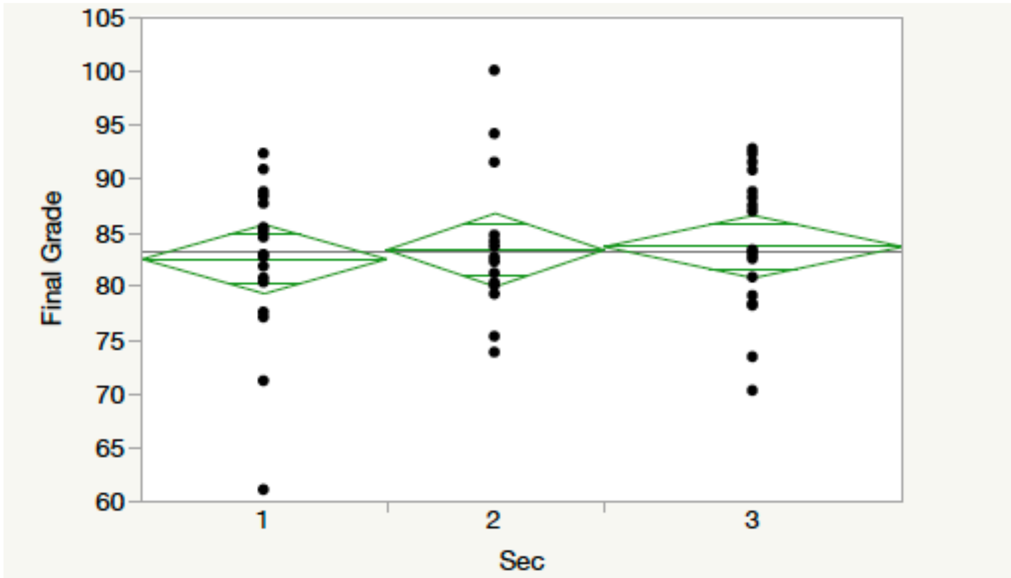

Figure 3: Means of Final Scores Among Course Sections.

Conclusions and Future Research

Industry wants engineering graduates with the requisite technical and soft skills who add value and have the ability to make a difference in the workplace. Industry values are further institutionalized through ABET [15] student outcomes, particularly (g): "[demonstrate] an ability to communicate effectively," and in the 2020 student outcomes (3): "an ability to communicate effectively with a range of audiences." Aligning academic programs with industry needs is critical in today's workplace and should be viewed as an investment. Instructional strategies and methods can be applied in the classroom to enhance critical skills needed by industry. Implementing an experiential, corporate-led, technical writing project reinforced the application of technical writing principles and authentic document creation, while also highlighting for students the importance of professional communication. Using a real-world project drives student engagement, as they become invested in the projects, reinforcing the idea that students must continually strive to update their skills throughout their careers. Incorporating more material in an engineering curriculum is not easy, but programs should realize the benefits of coordination with non-engineering faculty and nesting the goals of the institution and disciplines.

Moreover, student response to this project was positive, indicating that they appreciated a more hands-on approach to the Technical Writing Course. The short-term goals are to evaluate existing coursework and integrate more real-world applications that could make an impact on the students' learning. Some students reported concerns with the length of the project or other logistical issues, and this feedback guides the current implementation of this project during Spring 2019, which is reduced in scope and duration. Quantitative results indicate that (1) experiential collaborative learning has an impact, especially for struggling or intermediate-level performers; and (2) this impact is persistent through the duration of the course, resulting in performance parity for cumulative course scores.

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