Constructively Aligning Writing Skills with Scientific Content in University-Level Curricula

Abstract

Numerous national and global surveys indicate that employers care most about an applicant's communication skills when they hire recent college graduates. However, employers are overwhelmingly not satisfied with applicant preparedness in communication. To reduce this discrepancy, I designed, implemented, and evaluated a way to effectively incorporate written science-communication skills into any established science curriculum with minimal requirements of time, training, or resources. The intervention was implemented and evaluated in a university-level science course. Students completed pre- and post- written assignments, which were blindly reviewed and scored by STEM professionals. Students in the intervention group achieved significantly higher score changes than students in the control group, with slight improvements in individual skills compounding into a 13% greater average overall improvement. Reviews from academic and nonacademic professionals were similar, indicating that the skills taught in this intervention are beneficial to a wide range of possible STEM careers. The intervention was most effective for students earlier in the academic program, and the explicit teaching style proved to benefit students with lower GPAs. Instructors reported overall good perceptions of the intervention and agreed that the chosen written-communication skills were instrumental for all students regardless of their career trajectories. The results of this study suggest that incorporating short writing lessons early in university-level science curriculum in an explicit and scaffolded manner can effectively improve student writing skills and better prepare them for STEM careers.

Keywords: education, communication, writing, undergraduate, science, teaching and learning

1. Introduction

College curricula that focus solely on discipline-specific content, rather than cross-cutting skills like communication, fall short of what students need for career success. This claim has been corroborated by many recent surveys conducted in the United States (Graduate Management Admission Council, 2017; Hart Research Associates, 2015; National Commision on Writing, 2004) and worldwide (Australian Association of Graduate Employers, 2018; Busines Council of Canada & Aon Hewit, 2016; Karzunina, West, Maschiao de Costa, Philippou, & Gordon, 2018). These surveys consistently find that employers care most about an applicant's communication skills when they hire recent college graduates. However, only 27% of employers think that recent college graduates are well-prepared in written communication (Hart Research Associates, 2015), likely because few undergraduate curricula include coursework-based opportunities for students to practice communication skills (Brownell, Price, & Steinman, 2013b).

Beyond just career preparation, practicing written communication within a scientific degree program also facilitates better understanding of content (Spektor-Levy, Eylon, & Scherz, 2009). Because writers consider language and subject matter in parallel (Bereiter & Scardamalia, 1987), scientific meaning is clarified and solidified through written communication as cognitive exchange occurs between the scientific content problem and the rhetorical problem. In effect, written communication stimulates a better understanding of scientific text (Keyes, 1999) and increases student confidence in their ability to understand and communicate scientific literature (Brownell, Price, & Steinman, 2013a).

Experts in science communication reason that students need courses that are dedicated to teaching science communication rather than just a narrow set of discipline-specific skills (Bray, France, & Gilbert, 2012). Numerous commentaries by scientific leaders and educators have focused on the need for such training for both students and established scientists (Baram-Tsabari & Lewenstein, 2017; Brownell et al., 2013b; Bubela et al., 2009; Warren, Weiss, Wolfe, Friedlander, & Lewenstein, 2007). In response, undergraduate and graduate science degrees across the United States, United Kingdom, Canada, and Australia are more frequently including communication as a required learning outcome (Council of Ontario Universities, 2011; S. Jones & Yates, 2011; UK Quality Code for Higher Education, 2014) with the aim of creating a stronger link between undergraduate education and graduate employability (Bath, Smith, Stein, & Swann, 2004; Radloff, de la Harpe, Dalton, Thomas, & Lawson, 2008).

Writing proficiency as a learning outcome is generally set by universities and degree programs but is often not specifically targeted in curricular activities on a classroom level. Many barriers prevent instructors from incorporating written communication skills into their established science curriculum, including a lack of time, resources, and professional training in general skills outside of their specific discipline (Brownell et al., 2013b). Because an instructor's primary goal is to teach specific content, students are generally taught to communicate only within their own scientific field using conventional and technical language. A review of curricular assignments at five universities showed that 96% of science-assessment tasks involving communication were targeted at an audience of the same scientific discipline, as reported in Mercer-Mapstone and Kuchel (2016). This discipline-specific style of instruction narrows student perspectives, and, in effect, prevents them from effectively generalizing their findings, arguing their field's significance and relevance, and speculating about interdisciplinary implications (Pelger & Nilsson, 2018).

To bridge the divide between expected learning outcomes and curricular content, educators and communication experts have created modules that focus on science communication to diverse audiences. However, these modules often require a considerable amount of expertise from the instructor and time within the training program (e.g., Tilstra 2001; Yeoman et al. 2011; Mercer-Mapstone and Kuchel 2016; Moni et al. 2017). A clear need exists for a science-communication intervention that can be integrated into established undergraduate science curricula without requiring instructor expertise, taking a significant amount of additional time, or detracting from the scientific rigor of the training program.

Here, I present a syllabus that was designed, implemented, and evaluated to be easily integrated into established science curriculum and effectively incorporate the teaching and learning of written science-communication skills (Syllabus S1). Development of communication skills has been found to be most effective when taught within a subject context (Blasjo, 2004). Therefore, short in-class instructional periods on communication skills are nested within the scientific curriculum and are limited to <15 minutes per week. Communication skills are taught explicitly through a scaffolded learning framework, a step-by-step method that is effective when teaching complex skills, such as communication, by making the purpose and style of learning clear to the students (Archer & Hughes, 2011; L. D. Mercer-Mapstone & Kuchel, 2016; Rosenshine, 1986).

Because learning outcomes are best achieved when training is integrated, progressive, and varied (Pelger & Nilsson, 2018), each unit in this syllabus scaffolds the teaching of one or more skills essential to effective communication (Table 1) and is approached with multiple learning strategies: group discussion, individual reading, and regular practice. The units were developed to provide students with a conceptual, rather than context-specific, skill set that they can apply in a wide variety of contexts, including professional and casual communication within and across scientific disciplines. This intervention is intended to be adapted to multiple class curricula throughout a degree program so that students achieve persistent and recurring science-communication training, which can progressively enhance skills over time (Divan & Mason, 2015),

2. Methods

2.1 Design

Writing skills included in this curriculum were chosen from several evidence-based studies that determined which written-communication skills are most essential for teaching undergraduate science students (Table 1). Skills were taught sequentially in an 8-week long curriculum. During the first week, an overview and motivation of the curriculum was presented and learning objectives were explicitly described. In the last week, learning objectives and all writing skills were revisited and practiced in conjunction.

In-class activities, independent reading and practice, and assessments were constructively aligned (Biggs & Tang, 2011) each week to facilitate students' ability to achieve explicitly stated learning goals (Presentation S1). Once per week, a short presentation was followed by group discussion and call-and-response practice examples. These in-class discussions allowed students to take an active role in the learning process by engaging in reflection and dialogue (Cook-Sather, 2011). After class, students independently read a short lesson (~2 pages) further describing and exemplifying the weekly topic. Students then incorporated the relevant writing skill into their homework assignments. Assignments were designed so that students can explore their own personal interests as they related to the scientific content. For example, assignments often asked students to perform a scientific task then reflect on or justify their process, e.g. “In 3 sentences, reflect on your experience using the software so far. What is most enjoyable? What is most bothersome? Your answer will be graded on sentence structure.” Written responses to these writing-skill oriented prompts accounted for 33% of the assignment grade. Constructively aligning written practice with conceptual learning in this way enhanced the development of both writing skills and scientific literacy (Bereiter & Scardamalia, 1987) and familiarized students with expectations and reasoning skills required in their future careers (Brownell et al., 2013a).

2.2 Implementation

The curriculum was implemented and evaluated in a quarter-long science course at the University of [redacted]. The course, entitled Marine Geospatial Information Science (Ocean/Fish 452/502), was chosen because it included undergraduate and graduate students from a wide range of earth- and life-science departments, making it possible to determine for which type of students this curriculum is best suited (Table 2). Two instructors co-taught this course. To fluidly incorporate this science-writing curriculum into the established course, I served as the teaching assistant and led all intervention-related class activities. The instructors observed the intervention and provided personal feedback throughout the quarter.

Student demographic data and writing samples were collected in the 2017 and 2018 course offerings. For the 2017 course offering, hereon referred to as the control, curricular content and teaching strategies did not vary meaningfully from previous years. Then, for the

2018 course offering, hereon referred to as the intervention, the science-writing syllabus was incorporated into the scientific curriculum and classroom instruction. Students in both years completed two writing assignments, one during the first week of class (pre-assignment) and one during the last week (post-assignment). The assignment prompts were identical, asking the students to "write about yourself, a scientific topic that interests you, and how you see yourself addressing this topic in a possible future career," in 400-600 words.

2.2 Evaluation

Curriculum efficacy was evaluated with two methods: student performance and instructor perceptions. To quantitatively evaluate student performance, the pre- and post-assignments were each scored by three STEM professionals: two in academic fields and one in a nonacademic field. Reviewers were chosen from STEM fields so they could represent the employer expectations that the students are assumed to most likely encounter. Reviewers blindly scored a student's pre- and post-assignments based on a detailed rubric directly aligned with curriculum content and learning objectives (Table 2). For both assignments, each writing skill was scored on a Likert scale (5: Excellent with No Faults, 4: Good with Minor Faults, 3: Okay, 2: Poor with Many faults, 1: Fail with all Skills Absent). Additionally, reviewers directly compared pre- and post-assignments to score the overall change in writing skills on a scale from -5 to 5, without knowing in what order the assignments were written. To minimize the influence of any single reviewer (n=25), reviewers were limited to 10 student evaluations each.

Review results were analyzed in multiple ways. First, to determine if the intervention students' writing skills improved more than those of the control students, score changes for each skill (pre – post) and overall scores were compared using a Wilcoxon Rank Sum test.

Additionally, the difference in expectations between academic and nonacademic reviewers was evaluated with a one-sample t-test. Expectation differences were represented as the average score given by both academic reviewers minus the score given by the nonacademic reviewer for each student. Finally, to determine the influence of predictor variables (GPA, year in program, gender) on response variables (Likert survey answers), review results were analyzed using a conditional ordered logit model. Interactions between variables were not included due to the small sample size for some categories.

Instructor perceptions of the curriculum were gauged with a post-intervention survey. Instructors were asked to quantitatively score and qualitatively describe their opinions of the intervention's usefulness and relevance, effect on the standard of student work, clarity of expectations, and their personal comfort with future implementation and promotion. Instructors also provided recommendations for improvement of the curriculum.

3. Results

3.1 Student Performance

Blind evaluations of student writing assignments showed that students in the intervention group achieved significantly higher score changes (post-pre) than students in the control group (Fig. 1). Whereas the control group's written skills tended to decrease of remain constant over the course, the intervention group's written skills tended to remain constant or improve. The difference in score change between the two groups was found to be significant for writing skills of sentence structure (p=0.07), paragraph structure (p=0.01), word choice (p=0.04), and demonstration (p=0.08), though not for purpose, use of jargon, or audience and framing. While differences on any single writing skill were slight, with averages always <3%, the effect on overall perception was compounded. For overall perception, the intervention group earned a 10% higher median score and a 13% higher average score than the control group.

A reviewer's occupation, being academic or nonacademic, was generally not found to impact their evaluation of student writing skills (Fig. 2). Only the skill of demonstration[†] was found to be significantly skewed, with nonacademic reviewers tending to give slightly higher scores than academic reviewers for individual writing assignments. The interquartile range for this skill spanned from 1 point to -2 points on a 10-point scale. For overall scores, the nonacademic reviewer median score was 5% lower than that of academic reviewers with a significance level of 18%.

Results of the conditional ordered logit model indicate that the influence of predictor variables (GPA, year in program, gender) on response variables (Likert survey answers) varies between the two groups (Table 3, Fig. 3-5). For the control group, only student GPA was found to influence score changes. For most writing skills, students were ~2-4 times more likely to receive a higher score change with every unit increase in GPA, given all else equal.

In contrast, for the intervention group, student GPA was not found to be a significant predictor variable. Instead, students earlier in the academic program tended to respond better to the intervention than those later in the program. All sophomores and juniors in the intervention group (n=7) earned a positive overall score change, with an average improvement of >2 points (40%), whereas seniors and graduate students (n=27) received slight negative score changes on average (-0.5 points, -10%). Student gender was also found to be a significant predictor variable on both paragraph structure and word choice for the intervention group, with females ~2 times more likely to receive a higher score change than males.

3.2 Instructor Perceptions

The two instructors that observed this intervention reported overall good perceptions (Table 4). They agreed that the chosen written-communication skills incorporated into their course curriculum were instrumental for all students regardless of their career trajectories. Both instructors appreciated that the intervention was introduced in small, digestible pieces throughout the quarter, and one instructor commended the process of systematically linking communication skills with the course learning goals in a way that improved the course as a whole:

> *I was always encouraged by starting each class with an exercise that engaged students to "think, recall, and share" ideas about a common skill they all knew was important (i.e. writing) before jumping into skills which may or may not be applicable to their career plans… regardless of any quantitative educational assessment metric that might be descriptive of the outcomes of this intervention program, I feel that the structure, material, content, and format improved the learning environment of my class.*

Furthermore, the instructors thought students appreciated that the writing lessons were constructively aligned with content-related assignments so that basic instruction in writing style, wording, and structure techniques immediately preceded their application in weekly homework assignments. One instructor noted the impact of this instruction style on student work:

> *I did see (observed and heard) that students were more confident in their writing having been encouraged and reminded about best practices… I can say that students did write more often and their written responses… were more clear and easier to read than in past years.*

When the instructors were asked if they would feel comfortable incorporating this intervention into their own future classes and encouraging others to do so as well, both instructors reported being moderately to very comfortable and commented on their concerns. Their primary concerns regarded the effectiveness of the intervention, which this study aims to assess:

> *This [improvement in written responses to test questions] may have been just the simple fact that because the intervention was part of the class the students knew that good writing was expected and they would be evaluated partly based upon written communication – this implies that we should always tell students that written communication skills is a part of all science classes, so your writing is always being evaluated… the question I'm left with is if this method of 'intervention' into an existing course syllabus motivates students to apply those learned skills.*

> *[Before I implement or promote this intervention in the future,] I'd want to know what worked and what didn't work based on this quarter or past/future quarter results.*

Both instructors reported that if they were to implement this intervention themselves, or encourage others to do so, they would prefer the writing to be more incorporated into the in-class group discussions and/or overall course design:

> *I would only suggest that one might implement a 'rapid response of the skill'… when introduced. This means … when you ask students "How might we restate this sentence?", ask them to write their ideas in addition to sharing them out loud.*

> *My only real hesitation is that I would prefer having a bit more of a strategy for addressing the 'why' of what we are doing. If our class had a final project that was… some kind of science writing product, it seems that it would be easier to justify why we were talking about science writing to the students… It would be of interest to me to discuss ways of integrating writing lessons more smoothly into the curricula and/or learning goals of the whole course.*

Even with these concerns and suggestions, instructors reported optimistically on their comfort level and expected future success of the intervention:

> *… it is because the intervention was so good that I now know how much better it can be. Before participating in the intervention, I didn't know how good this approach to learning can be – now I see what it can do… I learned so much myself observing this intervention… At this point I feel only marginally*

comfortable leading this type of intervention myself. But for most instructors, once they observe the intervention and are given the material, they should have no problems.

4. Discussion

4.1 Intervention Efficacy and Impact

The results of this study suggest that incorporating short writing lessons (<15 minutes/week) into university-level science curriculum can effectively improve student writing skills (Fig. 1). This perceived difference in student learning is a product of student skills in the intervention group improving as well as student skills in the control group worsening. Students in the control group may have performed worse on the written post-assignment completed near the end of the course, as compared to the pre-assignment, for two possible reasons: indoctrination and stress. As academics become indoctrinated deeper into any single scientific discipline, their communication strategies, including grammatical constructions and assumptions of audience perspective, often narrow to suit a specialized audience of that discipline (Berkenkotter & Hucken, 1995; Golebiowski & Liddicoat, 2002). In effect, their ability to communicate widely across disciplines may worsen (Brownell et al., 2013b). Furthermore, students often experience increased stress near the end of an academic session due to an increased workload, perhaps causing students to feel as if they did not have enough time, energy, or motivation to complete the post-assignment to the best of their ability (Jacobs & Dodd, 2003; Kausar, 2010). Regardless of what caused written skills in the control group to worsen, students in the intervention group were more likely to overcome these hurdles and improve their writing skills.

A broad range of STEM professionals, both academic and nonacademic, reported similar perceptions of students' written assignments (Fig. 2), corroborating the instructors' perceptions that interventions like this one are instrumental for all students regardless of their career trajectories. Even though students in the intervention group were taught writing skills in the context of marine geospatial information science, they were able to conceptualize and implement these skills when writing to a diverse audience outside their discipline. Thus, this style of classroom instruction should help bridge the divide between employer expectations and student preparedness.

4.2 Student Disposition to the Intervention

Analytical results indicate that student GPA was a reliable predictor for student performance in the control group but not the intervention group (Table 3 and Fig. 3). This discrepancy may rely on the role of explicit and implicit learning. Implicit learning involves adapting to environmental expectations without being aware of how the adaptation was achieved (Frensch & Rünger, 2003). In traditional science classes that do not incorporate explicit instruction on written communication, students are left reliant on implicit cues from their instructor and instructional materials. The finding that GPA was a significant predictor in the control group suggests that students with higher GPAs may be more cognizant of implicit cues or more prone to implicit learning. Likewise, because GPA was not a significant predictor in the intervention group, the explicit instruction of this intervention appears to be a more effective and equitable teaching strategy for students with a wide range of GPAs.

A student's year in the academic program was a significant predictor of student performance in the intervention group (Fig. 4). Students earlier in the program, sophomores and juniors, tended to improve more than those later in the program, seniors and graduate students. Two possible reasons help explain this result (Brownell et al., 2013b). First, students earlier in the academic program may be more open to receiving instruction on basic skills, whereas more experienced students may have more confidence in their writing ability and less interest in changing their writing style. Second, sophomores and juniors may have more time and energy to devote to practice, while seniors and graduate students have more responsibilities, or responsibilities that they deem more important, that limit the time they can devote to learning writing skills. Thus, introducing communication skills earlier in a training program seems to be more effective. Accordingly, I encourage instructors to incorporate instruction on basic crosscutting skills that employers desire, such as written communication, into their degree program early and often. Early introduction paired with persistent explicit instruction should foster a learning environment where communication skills and scientific knowledge are recognized and developed in tandem to the betterment of each skillset.

4. 3 Answers to Instructor Questions

The two instructors that observed the implementation of this intervention valued the learning goals and were impressed with science-writing activities introduced into their curriculum. Though, they did report questions they wanted answered before they would be comfortable implementing the intervention themselves or recommending it to others. Their concerns were focused on efficacy and impact.

This intervention was found to be effective in that students were able to aggregate and apply skills they learned throughout the quarter in a single final writing assignment. Students in the intervention group achieved significantly higher score changes than those in the control group when STEM professionals blindly assessed their written assignments. While differences on any single writing skill were slight, the effect on overall perception was compounded and culminated into a 10% higher median score and a 13% higher average score for the intervention group. Therefore, instructors should expect this intervention to result in slight improvements to many individual skills that amount to greater improvements overall.

However, this evaluation did indicate that students did not significantly improve on all writing skills. Skills that require a high level of cognition, such as writing with a clear purpose and framing for a specific audience, were not significantly impacted by this intervention. I propose that integrating this intervention more thoroughly into the scientific curriculum, as was recommended by the instructors, may help students better understand and apply these more difficult skills. These skills may also require more persistent instruction so that students can explore and practice them in variety of classroom settings.

For these reasons, I urge instructors to incorporate written communication skills throughout a degree program rather than solely within a single course. Furthermore, instructors should document and share their experiences and results to aid others with similar teaching goals. Innovative teaching strategies are often developed in isolation and rarely published in academic literature. Instead, these innovations should be evaluated and shared so that other instructors can feel comfortable in their own implementation and confident in the expected results. In this way, degree programs can better meet their required learning outcomes and better prepare students in the communication skills expected by their future employers.

5. Summary

Goal:

Numerous national and global surveys indicate that employers care most about an applicant's communication skills when they hire recent college graduates. However, most undergraduate courses do not include coursework-based opportunities for students to practice these skills, and employers are overwhelmingly not satisfied with applicant preparedness in communication. To reduce this discrepancy, I designed, implemented, and evaluated a way to effectively incorporate written science-communication skills into established science curriculum with minimal requirements of time, training, or resources.

Methods:

Writing skills included in this intervention curriculum were chosen from several evidence-based studies that determined which written-communication skills were most essential for teaching undergraduate science students. The curriculum was implemented and evaluated in a quarter-long university-level science course. Students completed pre- and post- written assignments, which were blindly reviewed and scored by STEM professionals. Review results were statistically analyzed to determine the efficacy of the intervention as well as the influence of predictor variables (GPA, year in program, gender) on student performance. Instructor perceptions were gauged with a post-intervention survey.

Results:

Students in the intervention group tended to achieve higher score changes (post-pre) than students in the control group, with slight improvements in individual written skills compounding into a 10% greater overall improvement. Reviews from academic and nonacademic professionals were similar, indicating that the skills taught in this intervention are beneficial to a wide range of possible STEM careers. The intervention was found to be most effective for students earlier in the academic program, and the explicit teaching style proved to benefit students with lower GPAs. Instructors reported good perceptions overall and agreed that the chosen written-communication skills were instrumental for all students regardless of their career trajectories. They also stated that they would be more comfortable implementing and recommending this intervention in the future after its impact was evaluated.

Conclusions:

The results of this study suggest that incorporating short writing lessons (<15 minutes/week) into university-level science curriculum in an explicit and scaffolded manner can effectively improve student writing skills. For degree programs to better prepare students for their future careers, I urge them to incorporate interventions like this one early in a degree program and throughout multiple courses. Furthermore, they should document and share their experiences and results to aid others with similar teaching goals.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of [redacted] Human Subjects Division (ID: STUDY00003178) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Conflict of Interest

The author declares that they have no conflict of interest.

Figure Captions

Fig. 1 Distribution plots displaying score changes for students in the control and intervention groups. Statistical significance was determined with a Wilcoxon Rank Sum test and is symbolized as † ($p<0.1$), * ($p<0.05$), and ** ($p<0.01$).

Fig. 2 Boxplots demonstrating differences in scores given by academic and nonacademic reviewers. Differences are calculated as the average score given by both academic reviewers minus the score given by the nonacademic reviewer for each student. For each box, the central mark indicates the median, the box extends to the 25th and 75th percentiles, whiskers extend to the most extreme data points not considered outliers, and outliers are symbolized as open circles. Significance was determined with a one-sample t-test.

Fig. 3 Distribution plots displaying score changes colored by students' GPA. In the control group, students with higher GPAs tend to improve more that students with lower GPAs, but in the intervention group, there are no significant trends. Significance was determined with a conditional ordered logit model as shown in Table 3.

Fig. 4 Distribution plots displaying score changes colored by students' year in program. In the control group, there are no significant trends, but in the intervention group, sophomores and juniors tend to improve more than seniors and graduate students. Significance was determined with a conditional ordered logit model as shown in Table 3.

Tables

Table 1. List of skills taught, skill descriptions, and references that deem the skills essential for teaching communication to undergraduate science students.

	Description of Skill	*References*
Sentence Structure	Sentences are structured to be easily understand. Subjects and verbs are clearly coupled. Clauses create dynamic cadence without detracting from the clarity.	Bray et al. (2012) Gray et al. (2005)
Paragraph Structure	Paragraphs provide an engaging narrative arc, starting with set-up, then introducing a point of tension, and ending with a resolution.	Bray et al. (2012) Jones (1994) Mercer-Mapstone and Kuchel (2017)
Purpose	The purpose of the writing is clear and immediately obvious, e.g. persuasion, education, and/or entertainment.	Bray et al. (2012) Jones (1994) Mercer-Mapstone and Kuchel (2017)
Word Choice	Words used, specifically verbs and adjectives, are descriptive and strong. They are strategically chosen to reduce ambiguity and add clarity.	Gray et al. (2005) Jones (1994)
Use of Jargon	Jargon is used strategically to demonstrate the writer's knowledge and educate the reader. Audience familiarity with jargon is considered, and context clues are provided to aid the reader's understanding.	Mercer-Mapstone and Kuchel (2017)
Demonstration	Validity of claims is demonstrated with persuasive evidence and examples so that readers trust the writer and their claims.	Jones (1994) Yore et al. (2004)
Audience and Framing	The writing is focused on a singular, well-defined audience. Words, concepts, structure, and arguments are framed around the audience's perspective.	Bray et al. (2012) Jones (1994) Mercer-Mapstone and Kuchel (2017)

Table 2. Demographics of students in the control group (n=27) and intervention group (n=34).

	Total	*Male*	*Female*	*Sophomore*	*Junior*	*Senior*	*Graduate*
Control	27	8 (30%)	19 (70%)	0 (0%)	8 (30%)	9 (33%)	10 (37%)
Intervention	34	12 (35%)	22 (65%)	3 (9%)	4 (12%)	16 (47%)	11 (32%)

Table 3. The effects of predictor variables on response variables given as multiplicative factors for students in each group. For example, the likelihood of a student in the control group receiving a better score on sentence structure increases by a factor of 3.83 with every unit increase in GPA given all else is equal. Statistical significance was determined with a conditional ordered logit model and is symbolized as † ($p<0.1$), * ($p<0.05$), and ** ($p<0.01$). Blank boxes indicate insignificant relationships ($p>0.1$).

	GPA		*Year in Program*		*Gender (M to F)*	
	Control	*Interv.*	*Control*	*Interv.*	*Control*	*Interv.*
Overall				0.67 †		
Sentence Structure	3.83 **			0.64 *		
Paragraph Structure	2.85 *			0.47 **		2.03 *
Purpose	3.15 *			0.67 †		
Word Choice				0.58 *		2.38 *
Use of Jargon				0.64 †		
Demonstration	2.64 *			0.42 †		
Audience and Framing	2.48 †			0.55 *		

Table 4. Quantitative results of instructor survey. Color of circled answers indicates instructor identity: light grey = instructor 1, dark grey = instructor 2, black = both instructors.

Questions for Instructors:	*Score:*
Describe your overall impressions of the science-writing intervention.	poor 1 2 3 (4) 5 good
How clear and explicit was the teaching of the communication skills?	not at all 1 2 3 4 (5) very
Do you think skills taught in this intervention are useful and relevant in helping students write in a more clear and engaging manner?	not at all 1 2 (3) 4 (5) very
What were your impressions of how the students perceived and dealt with the communication skills being taught?	poorly 1 2 3 (4) 5 well
If provided with all the written and presentation resources, would you feel comfortable incorporating this intervention into future courses on your own?	not at all 1 2 (3) 4 5 very
Would you feel comfortable encouraging or mentoring other instructors to implement this intervention in their courses?	not at all 1 2 (3) 4 (5) very
Are there any changes you would recommend to improve the teaching of these communication skills?	many 1 2 (3) (4) 5 none
Did you notice any tangible differences in the quality of students' written assignments from this year compared to previous years?	decreased 1 2 3 (4) 5 increased

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Supplementary Information

Supplementary Information linked to the online version of the paper at Wiley

- Syllabus S1
- Presentation S1