Think Before (and After) You Speak: Practice and Self-Reflection Bolster Oral Communication Skills

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With limited funding and increased job competition, STEM professionals face a growing need to communicate their science. In this study, conservation biology faculty and practitioners from across the United States designed classroom exercises and teaching interventions intended to bolster oral communication skills. Through repeated oral presentation assignments integrated into course requirements, we examined individual student learning gains via quantitative assessments. We used two teaching modes: in an "intensive" version of a teaching intervention, students watched their presentations on video and reflected on their performance using a rubric; the "light" version included delivery of the rubric only. Students completed pre- and post-course surveys of student confidence, and pre- and post-exercise content knowledge questions. Faculty scored student performance on the basis of a detailed rubric encompassing components of effective oral presentations. We saw content gains accompany enhanced skill performance between the first and second presentations, with greater gains occurring during the intensive teaching intervention. Our results indicate that practice of a skill coupled with reflection on the process bolsters student learning.

Educating the next generation of students to address complex societal and environmental issues involves more than delivering scientific content. Undergraduate students need to develop effective process skills in leadership, communication, working in groups, critical thinking, data analysis, and project management to adequately prepare for careers in conservation science, policy, and practice (American Association for the Advancement of Science, 2011; Blickley et al., 2013; National Research Council, 2003; Rhodes, 2010).

Experts recognize that the training of conservation scientists and practitioners must emphasize effective oral communication (OC) skills, particularly across disciplines and to general audiences (Blickley et al., 2013; Cannon, Dietz, & Dietz, 1996; Chan, 2011; Noblitt, Vance, & DePoy Smith, 2010; Schmidt et al., 2012). Yet, if student practice of OC in conservation-related courses takes place at all, it generally involves a one-time, end-of-semester capstone presentation that may not provide adequately scaffolded skill development or otherwise meaningful training in, and expectations for, effective communication and feedback (Blickley et al., 2013; Muir & Schwartz, 2009). Assessment of OC in undergraduate education is usually instructor directed rather than using students' self-reflections or students' peer reviews (De Grez, Valcke, & Roozen, 2012). However, recent work has concluded that self-reflection, such as student reviews of video recordings of their own presentations, plays a key role in boosting student learning (Hammoud, Morgan, Edwards, Lyon, & White, 2012).

To improve our understanding of the investment needed for science students to learn process skills and for faculty to develop efficient teaching tools, the Network for Conservation Educators and Practitioners (NCEP) from the Center for Biodiversity and Conservation (CBC) at the American Museum of Natural History (AMNH) partnered with faculty teaching undergraduate conservation-related courses. We designed a large-scale, multi-institutional study on three fundamental process skills: critical thinking, data analysis, and OC. This article reports the results on OC skills, defined as the ability to make a prepared, purposeful presentation designed to increase knowledge; foster understanding; or promote change in the listeners' attitudes, values, beliefs, or behaviors (following Rhodes, 2010). We asked three key questions: (a) Does student repetition of an OC task improve performance? (b) Does instructor emphasis on communication skills affect the magnitude of individualized skill gains? and (c) Can students gain concept knowledge while practicing OC skills? To address these questions, we created and validated instructional materials designed to develop and assess OC skills and piloted these materials in diverse classroom settings across four institutions.

Methods

We conducted this study between April 2011 and August 2013. The project received an exemption from Institutional Review Boards (IRB) at all relevant institutions: AMNH, Clarkson University, Princeton University, James Madison University, Southwestern University, University of Maryland Eastern Shore, and University of Puerto Rico.

Developing, validating, and implementing assessment tools

Between April and July 2011, we developed and validated a set of instructional materials (Instructional Unit [IU]) for OC skills. The IU consisted of (a) a rubric for OC skills, (b) two exercises (with solutions) designed to develop OC skills, (c) a pre/post content knowledge assessment for each exercise, (d) a student's pre/post self-assessment of their OC skills, and (e) a light and an intensive oral communication teaching intervention (Figure 1). The IU can be downloaded by registering as an educator on the NCEP website (http://ncep.amnh.org).

Between August 2011 and August 2013, we implemented the IU following the experimental design shown in Figure 1. By using the IU in a single semester, we evaluated whether students gained OC skills, content knowledge, and self-confidence in their OC skills in courses that used the IU with one of the teaching interventions. By using both interventions (light and intensive) in the same course, albeit different semesters, we studied whether the degree to which oral communication is emphasized in a course influences students' overall OC gains. We implemented the IU in four higher education institutions from the United States and Puerto Rico in a variety of undergraduate courses (Biodiversity, Ecology, and Primate Conservation Biology), using a suite of different course styles (e.g., seminar, lecture; Table 1).

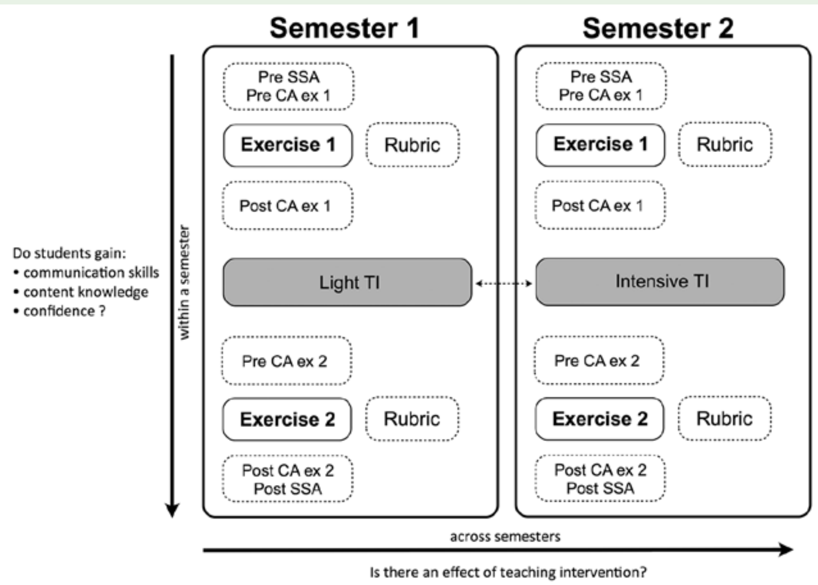
We based the OC rubric on elements found in other available reputable rubrics, including the Oral Communication Value Rubric (Rhodes, 2010). The resulting rubric included four performance levels (from 1 to 4) for six dimensions related to organization, content, comprehension, delivery, visual aids, and time. By using a collaborative and participatory approach to rubric development, we sought to validate rubric content, ensure familiarity of faculty participants with the rubric, and minimize scoring differences among project participants.

Exercise 1 asked students to assess the value or importance of a particular species, and Exercise 2 asked students to research and present convincing evidence for an area to be considered a high priority for conservation. Each exercise consisted of two parts: (a) an introduction to the main concepts of the exercise's topic and (b) detailed instructions to prepare a 5-minute oral presentation.

To measure OC gains at the individual student level, each student

FIGURE 1

Experimental design and main questions within and across semesters. The discontinuous arrow between light and intensive teaching interventions indicates an interchangeable order. Abbreviations are as follows: SSA = student self-assessment; CA = content assessment; ex 1 = Exercise 1; ex 2 = Exercise 2; and TI = teaching intervention.



delivered an oral presentation for each exercise. Students had at least two weeks to prepare presentations. Scores from both exercises contributed toward students' grades.

We measured reliability of the OC Exercises 1 and 2 by assessing their internal structure or consistency. The Cronbach's alpha coefficients (Bunce, VandenPlas, Neiles, & Flens, 2010; Cortina, 1993) obtained in a pilot study conducted at Princeton University in spring 2011 (N = 21 students; 0.6 and 0.7 for Exercises 1 and 2, respectively) and this study (N = 238 students; 0.6 for both exercises) indicate an acceptable internal structure of these assessments following the criterion of Bowling (2002; $\alpha \geq 0.5$).

To assess students' content knowledge on the topics of the exercises, we developed a short pre/post content assessment questionnaire for each exercise (Figure 1). We validated the content by interviewing six volunteers in a one-on-one format. We evaluated the interviewee's rationale used to construct answers (Beatty & Willis, 2007) and thus eliminated questions with limited ability to measure content knowledge. The final questionnaire contained a comparable total number of points for both exercises (18 and 15, respectively). We developed an instructors' scoring guide with the correct answers, a solution rubric, and criteria for assigning points to each answer.

We administered the questionnaires before and after students completed an exercise in a pre/post fashion (Figure 1). The preassessments took place before students received either a lecture on the exercise topic or the exercise itself as an assignment. Each questionnaire required about 10 minutes for students to complete. The scores of the pre/post assessments were not graded, but students did receive some fixed credit for participation.

After data collection, we post-validated the questionnaires for Exercises 1 and 2. We excluded questions that had ≥70% perfect score on the preassessment (following Smith, Wood, & Knight, 2008), and those for which faculty users reported a poor match with the exercise content or the solution rubric. Final analyses included three multiple-choice, one fill-in-the-blank and two open-ended questions for Exercise 1 and four multiple-choice and one open-ended question for Exercise 2.

To assess changes in student self-assessment, we developed a Likert scale (ranging from 1 to 5) survey that included three questions on students' self-confidence with their OC skills. We validated this tool by requesting feedback from faculty participants during its development. Instructors used the same tool at the beginning and end of the semester as a pre/post assessment, respectively (Figure 1).

To assess the effect of instructor emphasis on individual OC skill gains over a semester, we developed instructions and materials for a light and an intensive teaching intervention. We implemented the teaching

TABLE 1

Institution type, student level, class size, and implementation schedule of the courses that used the oral communication instructional unit with the light (light gray box) and intensive (dark gray box) teaching intervention.

Institution type	Course	Student level	Class size	Fall 2011	Spring 2012	Fall 2012	Spring 2013
Baccalaureate college –Arts & Sciences	Biodiversity	Freshman	25 students*				
Research University	Ecology	Sophomore	30 students				
Baccalaureate college –diverse fields	General Ecology	Sophomore	15–20 students				
Master's college and university	Primate Conservation Biology	Sophomore–Senior	15 students				

*Multiple sections of this course (4 per intervention) used the instructional unit with light and intensive teaching interventions.

TABLE 2

Overall average gains for science courses that used the instructional unit with the light and intensive teaching intervention (TI).

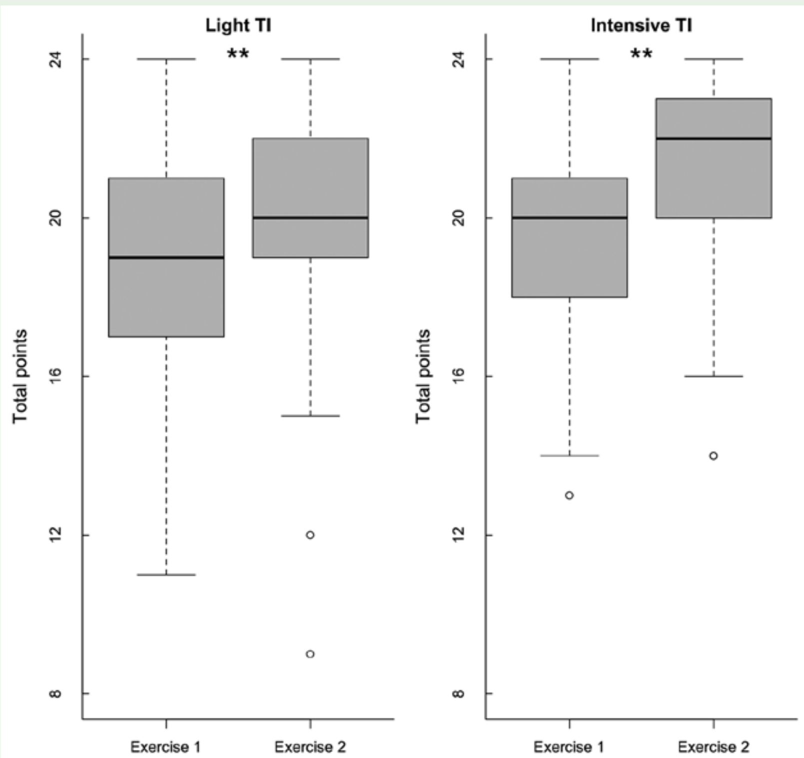
	Light TI			Intensive TI		
	N (%)[a]	Skill gains (c_{ave} ± SE)[b]	*P*	*N* (%)[a]	Skill gains (c_{ave} ± SE)[b]	*P*
Courses	96 (52)	0.24 ± 0.04		133 (70)	0.40 ± 0.03	
Median score (%)	79			83		
Below median	50 (70)	0.30 ± 0.05	**	59 (93)	0.52 ± 0.03	**
Equal to or above median	46 (33)	0.17 ± 0.05	n.s.	74 (51)	0.29 ± 0.04	n.s.

[a]Percentage of students that gained skills in parenthesis. [b]Average normalized gains ± mean standard error.

**$P < .01$; no significant (n.s.) gains between Exercises 1 and 2 using a paired Wilcoxon signed-rank test.

FIGURE 2

Total points obtained in Exercises 1 and 2 in courses that used the instructional unit with the light (V = 865.5; **$p < .01$) and intensive (V = 1054; **$P < .01$) teaching intervention (TI). Box plots show the median, upper, and lower quartiles, highest and lowest data values.



interventions between Exercises 1 and 2 (Figure 1), during lecture or lab time. All students, under both interventions, received the rubric at the outset of the semester. In the light intervention, students received their scored rubric from Exercise 1. If questions occurred, professors answered them during class but limited the total discussion to no more than 10 minutes. At the end of the discussion, professors reminded students that the same rubric would be used to evaluate their performance for Exercise 2 later in the semester.

For the intensive teaching intervention, after students completed Exercise 1, professors introduced students to the importance of OC skills and the use of rubrics. Then, students watched a 4-minute oral presentation on video, graded it with the OC rubric, and discussed possible scores for it in small groups. Once students increased their familiarity with the rubric, they individually reviewed at home a video of their own presentation from Exercise 1, keeping in mind the scored rubric from the instructor. A majority of the students were required to write reflections on this experience. Students then turned in an answer to the following questions: Which of the presentation criteria/elements in the rubric do you think is the most challenging for you, and what could you do to overcome that difficulty? The intensive intervention activity required 45–50 minutes of class.

Statistical analysis

To assess OC skills, content knowledge, and self-confidence, we calculated changes in student performance by using normalized change values (*c*) (Marx & Cummings, 2007) and compared pre and post assessments with paired Wilcoxon signed-rank tests (Crawley, 2007). Different teaching intervention groups were assessed independently. A *c* value ranges from –1 to 1 and represents the ratio of the observed change to the total possible change. For each assessment tool, we converted scores to percentages (up to 100) and calculated a *c* value for each student as follows:

- *c* = (post-pre)/(100-pre); if post > pre
- *c* = (post-pre)/pre; if post < pre
- *c* = 0; if post = pre
- drop; if pre = post = 0 or 100

The paired Wilcoxon signed-rank tests compared pre and post scores (total or average) for each student. We used Bonferroni corrections for all multiple comparisons (Gotelli & Ellison, 2004).

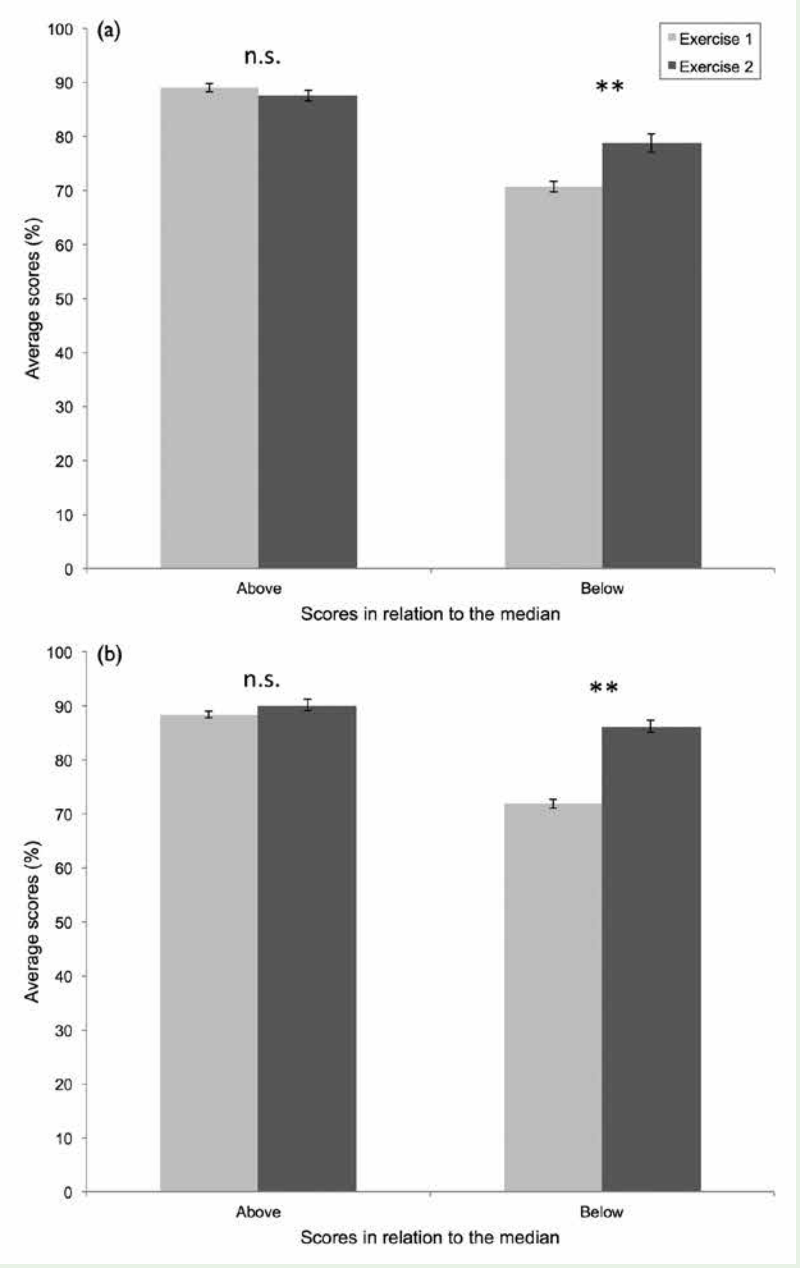
For the OC skills, we calculated *c* by converting the total points from the rubric scores for each exercise (maximum of 24 points) to a percentage (up to 100) and performed the Wilcoxon test on total points obtained in Exercise 1 (pre) and 2 (post). In addition, to determine which students improved the most, we calculated *c* average values for students whose Exercise 1 scores fell below the median and for those above or equal to the median. To determine changes in rubric dimensions, we compared the points from each dimension (4 points maximum) for Exercises 1 and 2.

To assess content gains, we calculated *c* values using the scores of each pre- and post-content assessment for Exercises 1 and 2 separately. Similarly, we performed the Wilcoxon test on the total percentage score of the content assessment for Exercises 1 and 2.

To assess gains in student self-confidence, we calculated *c* using the averaged scores for the three self-

FIGURE 3

Average scores for Exercises 1 and 2 of students who scored above or equal to and below the median in courses that used the instructional unit with a light teaching intervention (a) and an intensive teaching intervention (b). Asterisk indicates significant differences (***P* < .01) and n.s. indicates no significant differences (*P* > .05). Error bars are *SE* of the mean. (a) *N* = 50 and 46, respectively, for students below and above the median; (b) *N* = 59 and 74, respectively, for students below and above the median.**



assessment questions but performed the Wilcoxon test on each question separately.

We explored the correlation between the *c* values of skill and self-confidence, as well as the correlation between the *c* values of skill and the average gain in content knowledge for Exercises 1 and 2 using Pearson correlation analyses.

We tested for the effect of instructor emphasis on individual OC skill gains using the light versus intensive teaching interventions with a linear mixed-effects model. We used the percentage score difference between Exercises 2 and 1 as a response variable and institution as a random factor (Faraway, 2006). We tested for normality and homogeneity of variances of the residuals of the model. We used the difference between percentage scores of Exercises 2 and 1 because *c* values do not meet a normal distribution requirement and do not have a known distribution.

All calculations and statistical analyses were performed in R (R Development Core Team, 2012) with code developed by Adriana Bravo.

Results

Students gained in OC skills within a single semester. On average, students improved their performance by 24% with the light teaching intervention and by 40% with the intensive teaching intervention (Table 2). Paired comparison of total points obtained in Exercises 1 and 2 for the light and intensive teaching interventions support these results (Figure 2).

With the light teaching intervention, students with Exercise 1 scores below the median showed higher gains than students with scores equal to or above the median (Table 2). On average, they improved their scores from 71% to 79% (Figure 3a). Furthermore, 70% of these students reported positive gains (Table 2). On the other hand, students above or equal to the median did not change their average score.

We found similar results for students in courses with an intensive teaching intervention (Table 2). Students below the median significantly improved the average score of 72% to 86% (Figure 3b), with 93% of these students gaining skills. In agreement with results from the light teaching intervention, students above or equal to the median did not show significant change in their average scores (Table 2; Figure 3b). On average, they gained 30% in OC skill, with 51% of the students reporting positive gains. While present, losses were negligible in both light (average loss $c_{ave} = -0.105$) and intensive (average loss $c_{ave} = -0.125$) teaching interventions.

In a detailed analysis for each OC dimension, we found that the level of students' improvement on these dimensions varied between the light and intensive teaching interventions (Table 3; Figure 4). Under the light teaching intervention, students significantly improved in only two of six dimensions: *Delivery and language* and *Visual aids and text* (Table 3). On the other hand, in courses that used the intensive teaching intervention, students significantly improved in five out of six dimensions measured by the rubric (Table 3). When we examined the distributions of students across levels of performance for Exercises 1 and 2, we found that most students already exhibited high levels of achievement for *Organization* and *Student comprehension* (Figure 4a and c, respectively). For the other four dimensions, each showed slightly different patterns (Figures 4b, d, e, and f, respectively) under the different teaching interventions.

We found a gain in students' content knowledge for Exercises 1 and 2 with the light and intensive teaching intervention (Table 4). We observed significant gains between the pre- and post-content assessment scores for Exercise 1, but no significant changes

TABLE 3

Changes observed between the pre- and post-assessment scores for the six dimensions of oral communication skills when using the instructional unit with the light and intensive teaching intervention (TI).

	Light TI (*N* = 96 paired tests)	Intensive TI (*N* = 133 paired tests)
Skill dimensions		
Organization	V = 273	V = 60***
Content and supporting evidence	V = 570	V = 334.5***
Student comprehension	V = 414.5	V = 161***
Delivery and language	V = 222*	V = 420***
Visual aids and text	V = 380***	V = 862***
Timing	V = 852	V = 1115.5

Note: V = values for the paired Wilcoxon signed-ranked test.

*$P < .05$. **$P < .01$. ***$P < .001$.

occurred for Exercise 2 (Table 4).

We found a significant increase in students' self-confidence on their abilities to distinguish, prepare, and deliver an effective oral presentation over the course of a semester when using the IU for either intervention strategy (Table 5). In addition, most students went from being somewhat confident to highly confident for all three tasks under both teaching interventions (Figure 5).

We did not find a correlation between gains in OC skills and self-confidence (N = 203 students; cor = 0.02; 95% confidence interval: –0.11, 0.16; P = .8) or between gains in OC skill and content knowledge (N = 186 students; cor = 0.005; 95% confidence interval: –0.14, 0.15; P = .9).

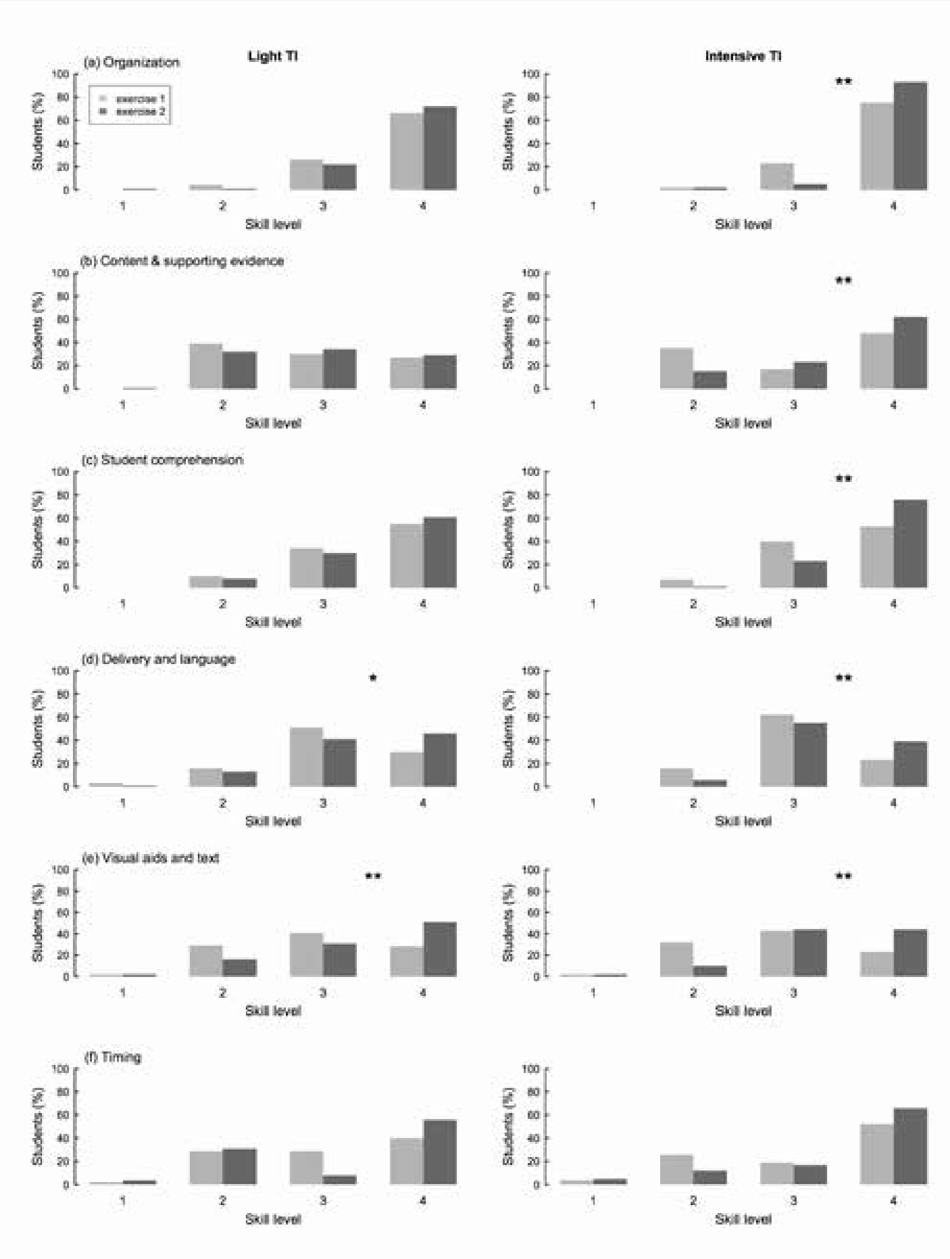
We found a significant effect of the intensity of the teaching intervention on skill gains (N = 229 students; $F_{(1, 224)} = 6.437$; P = .01). With the light teaching intervention, 50% of students gained skills (N = 96) compared with 70% with the intensive teaching intervention (N = 133; Figure 6).

Discussion

Our results clearly show that instructors using the IUs developed as part of this study observed a gain in student oral communication skills within a single semester and that the intensity of teaching meth-

FIGURE 4

Frequency distribution of students' performance within the four levels of proficiency for oral communication skills (1 = lowest, 4 = highest) when using the instructional unit with the light (N = 96 students) and intensive (N = 133 students) teaching interventions. Asterisks indicate significant differences (P < .001 and *P < .008) between the pre- and post-assessment rubric scores Bonferroni corrected.**



od positively influenced the gains observed. Professors who implemented the intensive intervention, wherein they explained the importance of communication skills and fostered practice and self-reflection in students, noted a substantial improvement compared with the light intervention where students received more passive feedback.

TABLE 4

Gains in students' content knowledge measured as the average normalized change (c_{ave}) and changes in scores (%) between the pre- and post-content assessments of Exercises 1 and 2 when using the instructional unit with the light and intensive teaching intervention (TI).

	Light TI	Intensive TI
Content assessment		
Exercise 1		
N (paired assessments)	76	120
Gains *(c)*	0.24 ± 0.04 (SE)	0.21 ± 0.03 (SE)
Pre vs. post scores (%)	V = 392***	V = 788***
Exercise 2		
N (paired assessments)	67	118
Gains *(c)*	0.12 ± 0.05 (SE)	0.1 ± 0.03 (SE)
Pre vs. post scores (%)	V = 402	V = 1152

Note: V = values for the paired Wilcoxon signed-ranked test.

****P* < .001.

TABLE 5

Total normalized change and changes in students' self-confidence with their oral communication skills before and after using the instructional unit with the light and intensive teaching intervention (IT).

	Light TI	Intensive TI
Student self-assessment		
N (paired assessment)	76	129
Gains *(c)*	0.3 ± 0.04	0.31 ± 0.03
Confidence to distinguish an effective from an ineffective oral presentation	V = 209	V = 207**
Confidence to prepare an effective oral presentation	V = 93**	V = 310.5**
Confidence to deliver an effective oral presentation	V = 240**	V = 598**

Note: V = values for the paired Wilcoxon signed-ranked test.

**P* < .016. ***P* < .003.

This supports other studies showing the benefits of case study–based exercises and student independent data analysis and research in association with OC assignments (Noblitt et al., 2010). Other studies affirm that assessment, both self- and peer-based, engages students actively in their own learning process (Ozogul & Sullivan, 2009), and video documentation enhances this process. The use of video for self-assessment and reflection has a long history in teaching for some fields (Hammoud et al., 2012), with evidence of effective teaching from across disciplines spanning from foreign language training to medicine (Castañeda & Rodríguez-González, 2011; Silliker, 1994). Tatar, Chachra, Zastavker, and Stolk (2010) even noted the efficacy of video and self-reflection in learning other process skills such as team building and management. Video use has the potential to increase in classrooms as technological advancements simplify the logistics.

However, Hammoud et al. (2012) discussed several studies in which video review with self-assessment showed limited effectiveness without standards (such as the use of rubrics and models of effective communication) and feedback from faculty and peers. We believe self-reflection after review of individual video presentations and feedback from professors together provided the critical components to student success in our study. We advocate for more research in this area to discover the ideal combination of efforts.

Practice, including watching effective communication as well as designing and implementing a presentation, provides students with a baseline for comparison and improvement and likely promotes increased self-efficacy (Trujillo & Tanner, 2014).

In our study, we witnessed a boost in students' perceptions of their confidence in OC and their ability to recognize, prepare, and execute a quality oral presentation. Although students worked diligently and received quality grades for the first species-level talk, this presentation ultimately served as a "first go" at mastering such skills and laid the groundwork for improvement.

The assessment of repeated assignments parallels a scaffolding approach used to improve scholarly writing in students, widely adopted through programs such as Writing Across the Curriculum (Bazerman et al., 2005; Gazza & Hunker, 2012; Thaiss & Porter, 2010). Repeating an oral assignment within a semester gave students opportunities to "revise and resubmit" as they may do with papers. Kolber (2011) found a similar increase in student OC performance in senior biology students for both individual and group presentations repeated over the course of one semester.

The improvement in OC performance with more intensive intervention affected more dimensions of the skill (five out of six), whereas the (lower) improvement in skills for the light intervention only noticeably surfaced in the *Delivery and language* and *Visual aids and text* skills. In the light intervention, we speculate that students only fixed the "surface-level" problems of poor quality slides or simple delivery errors (i.e., no eye contact, excessive use of pet words, speaking too quickly, or simply not practicing at all). These two dimensions of *Delivery* and *Visual aids* also contain elements that students can likely self-assess better than dimensions like *Student comprehension* or quality of *Supporting evidence* that rely partially on the level of experience of the instructors. With the

FIGURE 5

Frequency distribution of students' self-assessed confidence levels with their oral communication skills when using the instructional unit with the light (*N* = 76 students) and intensive (*N* = 129 students) teaching intervention. One and two asterisks indicate significant differences between pre- and post-assessment scores with *P* < .016 and *P* < .003, respectively, Bonferroni corrected.

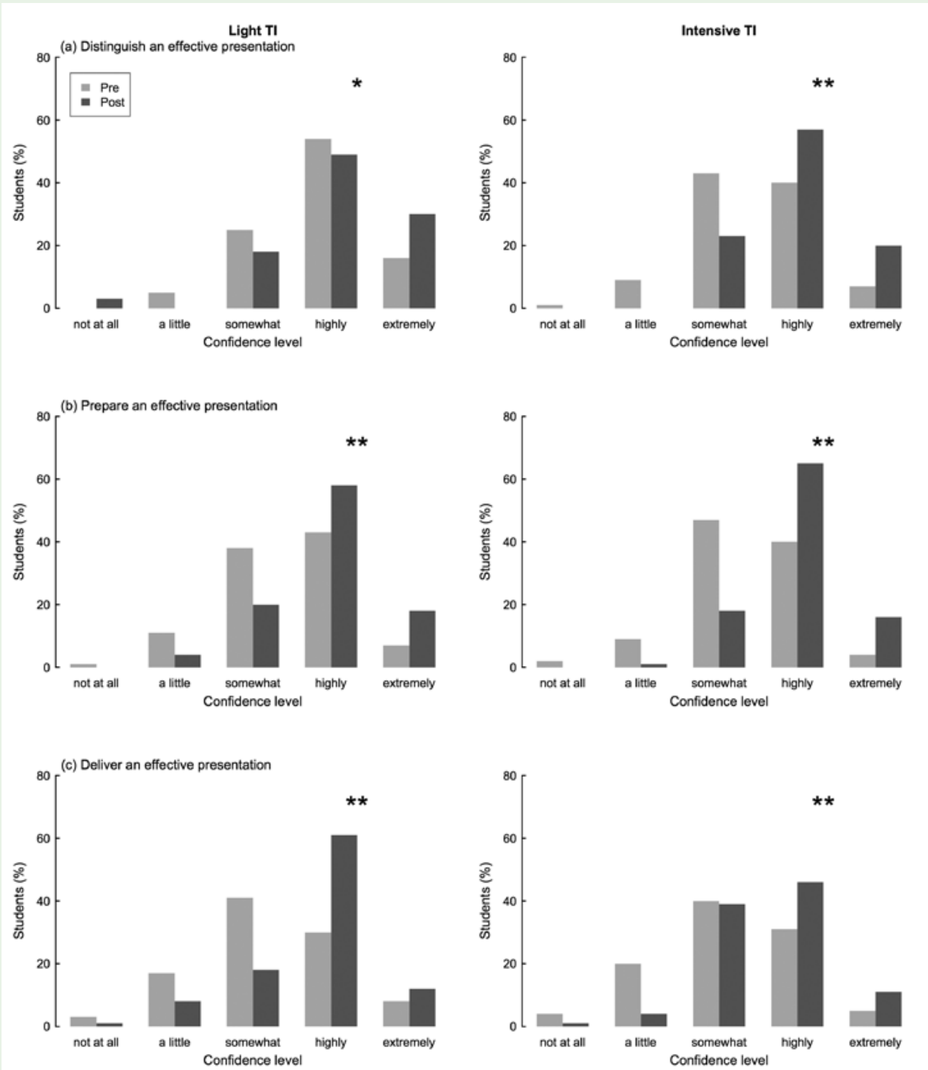
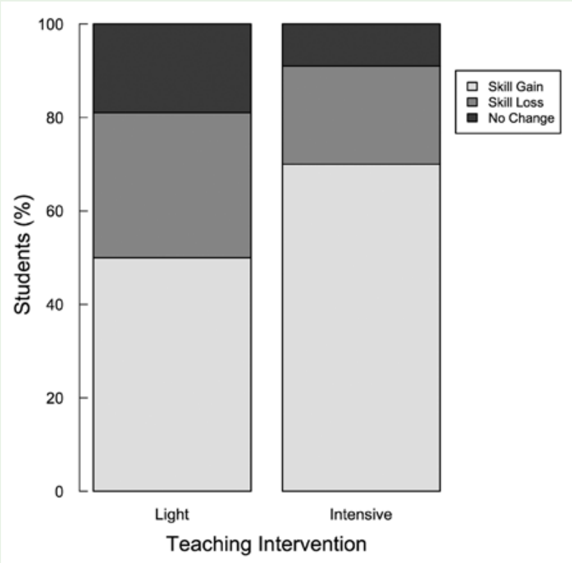


FIGURE 6

Comparison of the effect of the intensity of teaching intervention on skill gains ($N = 229$ students; $F_{(1, 224)} = 6.4$; $P = .01$). Light teaching intervention, $N = 96$; intensive teaching intervention, $N = 133$.



intensive intervention, faculty sought to engage students more deeply on all aspects of the rubric. This included answering questions about how best to integrate supportive evidence and what presentation strategies help showcase student comprehension. In the intensive intervention, these more sophisticated dimensions likely boosted self-efficacy (Trujillo & Tanner, 2014) as students gradually got more comfortable with a topic. Using the rubric in a "formative" manner—repeating its use across the two exercises—probably helped students to focus and partially explains the skill increase within the semester.

For students who read the directions, the substantially structured assignment also probably facilitated organization from the beginning of the exercise. Instructors felt that students might not have examined the rubric closely before the first presentation. However, after reflection and faculty feedback, students intentionally reviewed the rubric criteria, accounting in part for higher scores later in the semester. In addition, we noted that students who scored below the median exhibited greater gains than other students in skill improvement. Consequently, the overall approach of aligning exercise rubrics and teaching interventions may have a positive influence, particularly on lower performing students in a classroom.

Panadero and Jonsson (2013) found that formative use of rubrics facilitated assessment transparency, which may reduce student anxiety. Formative rubric use also appeared to aid the process of providing feedback, improved student self-efficacy, and supported student self-regulation, all potentially resulting in enhanced student performance (Dunbar, Brooks, & Kubicka-Miller, 2006; Panadero & Jonsson, 2013; though see Reddy & Andrade, 2010, for challenges in rubric use).

Our study design did not focus on the mechanism of the intensive intervention, and we did not examine the relative impact of these activities versus alternatives such as using rubrics or watching a good presentation by other students. The management of videos and sharing with individual students proved cumbersome so most instructors opted to provide only one video experience for assessment purposes (Exercise 1). Ideally students would have been able to compare both of their presentations in video format, and pre and post videos would have allowed instructors to randomize and independently score presentations to decrease the potential for bias in instructor scoring. Nevertheless, we reduced scoring bias by separating data from Exercises 1 and 2 into discrete data collection sheets so instructors could not see the student's first score when entering the second. Instructors received specific instruction not to refresh their memories regarding Exercise 1 prior to scoring Exercise 2. Future efforts need to streamline handling of large video files while still maintaining student privacy.

In terms of confidence, we found significant gains at the end of the semester in several elements including the students' confidence in their ability to distinguish effective from ineffective presentations and to prepare and deliver effective oral presentations. Although our study design only allows for a preliminary assessment of the correlation between confidence and skills, the lack of evidence for a correlation is important to note, as self-assessed confidence is often used as a proxy for skill development.

We observed statistically significant gains in content knowledge for Exercise 1 and slight, but nonsignificant gains for Exercise 2. The other IUs designed and applied in the course of our study that focused on data analysis and critical thinking produced different results. We observed significant gains in content in relation to all exercises in those units (Bravo et al., 2016; Porzecanski et al., 2016). We hypothesize that the results obtained in OC could be related to students' familiarity with the idea of habitat value (the subject of Exercise 2), compared with the value of a specific species (the subject of Exercise 1), which could have contributed to higher pre-test results.

Overall, we interpret our results as evidence that attention to skills development appears compatible with the development of content gains and that process skill practice can benefit students in many different kinds of courses. Students can improve certain elements of their OC skills in a short time period with the added benefit of knowledge gains. An emphasis on process skills by instructors, through more intensive practice, or through more opportunities to practice during a full program of study, could result in even more substantial gains.

Two oral presentations per student, even short presentations, plus the instructor interventions proved time intensive. Instructors are often hard-pressed to adequately treat all of the essential topics of a course in a semester, and our instructors certainly faced this challenge. However, from the instructors' standpoint, the learning and practice of authentic process skills was worthwhile; students improved in skill and confidence in presenting professional talks on conservation science. Moreover, students seemed to appreciate learning the material presented by their peer students and were engaged and motivated to do good presentations themselves. We believe that the assignment of the talks and associated exercises helped students better see the relevancy of the course content. It would be worthwhile to further investigate this potential benefit of oral exercises in conservation science coursework.

From our experience, practice alone without an accompanying analysis of performance proves less effective, and we recommend that students be given the opportunity to reflect in a structured way before and after they speak. As with scaffolding writing, the process of drafting and revision takes time. Some professors in our study thought that the second round of talks met their expectation for quality improvements, whether or not the students critically reflected on their actions. Others felt that students who took the reflection element seriously experienced intangible learning gains that will serve them well into the future.

Although the design of this project across multiple institutions magnified organizational challenges, we feel the results are more robust than work carried out within one classroom or one institution. We recommend further work be undertaken at this scale to broaden existing cross-institutional work (Gormally, Brickman, & Lutz, 2012; Gottesman & Hoskins, 2013; Hagenbuch et al., 2009) and to better understand development of process skills for biodiversity conservation.

In sum, oral communication is a key component of successful scientific engagement in societal issues such as conservation. Training in process skills and content are equally important for understanding and "doing" conservation. This study shows that we can engage skills training without compromising content. On the basis of our results, we recommend that future efforts try to incorporate more opportunities to reflect and revise in student work, we counsel against use of self-assessed confidence as the only proxy for skill development, and we encourage formative use of rubrics in skill development. ■

Acknowledgments

This project would not have been possible without the data collection efforts, dedication, and contributions made by the project's faculty participants. We also extend our gratitude to Patrick Onyango at Princeton University for help in piloting the initial experimental design and to G. Bowser, A. Gomez, S. Hoskins, K. Landrigan, D. Roon, and J. Singleton for their contributions to the initial design of the instructional materials. We thank J. Gibbs for his contributions to instructional materials and the students in our courses for participating in the research. This project was supported by the National Science Foundation (NSF) CCLI/TUES Program (DUE-0942789). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect NSF views.

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