

Inclusive Science Writing about Socioscientific Issues for Diverse Audiences

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Abstract

In this paper, we present a science writing assignment in which students focus on targeting specific audiences when writing about a socioscientific issue as well as participate in a peer review process. This assignment helps students consider inclusive science communication in their writing, focusing on engaging unique audiences about the intersections of science and social justice. Students are introduced to evidence-based tools for formulating communication for unique audiences as well as for assessment of writing quality. This assignment is novel in that it helps students think about inclusion issues in STEM, science writing, and peer review, all of which are key disciplinary skills that are not always included in STEM courses. While this assignment was piloted in chemistry and environmental engineering courses, this assignment could easily be modified for other disciplines.

In this assignment, students in an upper-division writing course in the chemistry curriculum were asked to identify a socioscientific issue related to climate change and the chemistry they have learned about so far in their major and consider how to communicate about that issue with two different, specific audiences. Similarly, students in an upper-division environmental engineering course focused on social justice were asked to identify an environmental justice issue that they have learned about so far in their major and consider how to communicate about that issue with two different, specific audiences. Utilizing the COMPASS Message Box (“COMPASS: The Message Box Workbook,” n.d.), students were directed to outline and write two one-paragraph assignments, one targeted at each audience. Students were encouraged to think about values of each audience, why they do or should care about the issue, how the audiences could be involved in solving the issue, or how the audience might benefit from a proposed solution to the issue. Students then utilized a modified version of the Universal Science Writing Rubric (USWR) (Pisano et al., 2021) to perform a peer review of each other’s writing before completing final drafts of their paragraphs in response to this peer feedback.

The COMPASS Message Box was originally designed by the COMPASS science communication organization as a tool for researchers to talk about their research with diverse public audiences and help the audience understand why it is relevant (“COMPASS: The Message Box Workbook,” n.d.). COMPASS provides a downloadable version of the Message Box on its website (<https://www.compasscicomm.org/leadership-development/the-message-box/>). The Message Box involves identifying an audience, describing the specific problem the researcher is addressing related to an issue, identifying the “so what?” or importance of the work, identifying potential solutions to the problem, and identifying who benefits from those solutions. Each of these categories includes prompting questions for the scientist to consider as they build their message.

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This tool can be utilized for STEM students to outline their communication via talking or writing about any scientific issue, not necessarily just something that is the topic of their research. The act of identifying a specific audience (e.g., schoolteachers and not just “the public”) and a specific component of a larger problem (e.g., recycling in schools and not just “environmentally friendly practices”) can help students to target specific audiences clearly instead of vaguely. Identifying how that audience can be part of the solution—versus just handing down a scientific solution—helps make the Message Box have a more inclusive science communication focus versus a unidirectional presentation of facts. When we presented the Message Box to students, we encouraged them to use it as a tool to frame a persuasive argument (Jiménez-Aleixandre & Erduran, 2007) to the unique audiences, considering how those audiences could be involved in solutions to socioscientific issues and not just informed about the issues.

Once students wrote paragraphs using the Message Box as a guiding outline, we directed them to peer review each other’s writing using the USWR. The USWR was designed as a tool to assess science writing in diverse genres. This rubric focuses on science content, interpretation of the science content, targeting the audience, organization, and writing quality. These diverse rhetorical concerns are all important for clear science writing to achieve its purpose. This rubric can be used for instructor grading, peer review, programmatic assessment, and more (Pisano et al., 2021). In our second iteration of this assignment, we added some more specific questions to guide student peer review based on this specific assignment. These questions included a focus on the accessibility of the language and verbiage for the specific audience, consideration of different audiences’ perspectives about the socioscientific issue, and attention to the potential for audience involvement in solving the issue.

The goals of this assignment were two-fold. First, we aimed to help students think about science writing from an inclusive science communication perspective, considering the perspectives of diverse audiences in their writing. The growing inclusive science communication movement encourages a transition away from the model of science communication as one-directional communication from scientists to an ignorant, monolithic public and towards the model of science communication as a collaboration between scientists and people of a variety of diverse perspectives within a community (Canfield et al., 2020). These diverse perspectives can include diversity of audiences in terms of identities they hold as well as diversity in terms of disciplinary expertise they bring to an issue (Vickery et al., 2023). There are multiple considerations of inclusive science communication, such as reflexivity, intentionality, and reciprocity, that can be manifest in different spheres of influence, such as at the interpersonal level or the policy level (Callwood et al., 2022). By encouraging students to engage unique audiences in their writing about an issue and consider how that audience could be involved in a solution to the issue, rather than simply explain the issue to a passive audience, we were aiming to promote a more inclusive approach to science communication. Second, we aimed to give students practice in the critical skill of peer review that they would continue to perform throughout the course. Other assignments have focused on the peer review process for college students (Samarasekara et al., 2020), and we combined this critical skill with inclusive science writing.

Context for the assignment

We have piloted this assignment in two different contexts. First, we piloted the assignment in Week 2 of a 300-level chemistry course focused on science writing. This course also fulfills the university’s core (general education) curriculum as well as guaranteed transfer pathways credits in the state. In particular, this assignment set students up for additional writing and peer review/editing assignments later in the course. We also piloted this assignment in a 400-level environmental engineering courses focused on environmental justice. This assignment set

students up for more extended writing assignments about socioscientific issues later in the course. By piloting this inclusive science writing assignment in both a science-writing-focused STEM course and an inclusive science-focused STEM course, we show its versatility.

Rationale for the assignment

Too often, science communication training for STEM students fails to integrate issues of diversity, equity, and inclusion (Canfield & Menezes, 2020). In analysis of published science communication training for undergraduate students, we noted that these trainings usually focus on either disciplinary STEM communication skills like writing or poster presentations for fellow scientists or focus on simply removing jargon in order to reach the public (Vickery et al., 2023). Many of these trainings do not guide students to consider the nuances involved in communication in a more inclusive way that invites public participation in the process of science (Akin, 2017; Baram-Tsabari & Lewenstein, 2017); neither do they consider the need for diverse perspectives to solve complex scientific issues. Especially in light of COVID, climate change, and other issues at the intersection of science and society, scientists are increasingly called to co-create solutions with people of various backgrounds (Nogueira et al., 2021) and to consider the social justice ramifications of these socioscientific issues.

In response to these needs, some of the authors (NK and SA) have been working to integrate inclusive science communication training into STEM courses across our university campus. These trainings include connecting social justice and scientific issues as well as inclusive perspectives on disciplinary STEM skills like science writing, reading the scientific literature, and giving oral presentations. The assignment described here was created in that context.

Related to the discipline of science writing, the recently published USWR was designed to assess any genre of science writing, from lab reports to review articles to news reports, regardless of audience (Pisano et al., 2021). This rubric allows assessment of science writing skills across different STEM writing assignments. Initially, the rubric was evaluated for use in grading; here we test its utility for peer review within a classroom. Other flexible, cross-genre rubrics have been developed to encompass quality science writing (Grady et al., 2022; Harrington et al., 2021). However, there are some critiques that such flexible or universal rubrics are too generic to be useful (Anson et al., 2012). To address this concern, in our second iteration of this assignment we provided more assignment-specific questions for students to consider in the “Targeting the audience” portion of the USWR. Since this assignment was particularly focused on utilizing the Message Box to frame two unique messages to two unique audiences, we instructed students to particularly pay attention to this portion of the rubric and guide their scoring with the assignment-specific questions.

Experiences of teaching the assignment

Two of the authors (NK and SA) taught the assignment as guest speakers in the courses. Although the assignment could have been delivered by the instructor of the course, in our experience, it was useful for outside experts in science communication to provide a short introduction about the concept of inclusive science communication. Our introductory lecture emphasized the importance of moving away from a deficit-based approach to scientific communication, in which scientists view the public as a non-informed monolith. Instead, students were encouraged to adopt an inclusive approach, addressing the unique needs, values, interests, and experiences of diverse audiences as well as listening to and learning from these audiences (Canfield et al., 2020). We provided a description of the different considerations of inclusive science communication, such as reflexivity, intentionality, and reciprocity, and how these can be manifest at different

spheres of influence, such as at the interpersonal level or the policy level (Callwood et al., 2022). This gave the students ideas of various considerations they could address in their writing. In the environmental engineering course, this assignment was in the context of other teaching on social justice throughout the semester.

We then had a class discussion about the COMPASS Message Box (“COMPASS: The Message Box Workbook,” n.d.) and helped students brainstorm ideas for their writing before deploying them to begin the writing assignment. The teaching session took about 30 minutes, allowing 20 minutes for student brainstorming and class discussion about the writing assignment before instructing the students to finish their draft paragraphs as homework. Students were assigned to use the Universal Science Writing Rubric (Pisano et al., 2021) for the peer review process and final draft writing via online asynchronous work. We discussed this rubric with the students before they began their writing assignments.

Overall, we provided about 30 minutes of teaching and discussion as described. Students then had 15 minutes to begin their outlines and paragraphs during class. We closed the 50-minute class sessions with five minutes of students sharing their messages and how they talked about a social justice issue differently to the two different audiences.

Our perspective of students’ experiences of the assignment

Students were asked to select a topic related to climate change, environmental justice, or another socioscientific issue of their choice. No two students selected the same topic, reflecting their diversity of interests. The diversity of the students’ passions and personal experiences was evident in many of the essays. Not only were the topics chosen by the students varied, but so were the audiences to which the students aimed their writings. Specifically, the students chose precise and specific target audiences that were extremely relevant to the socioscientific issue they chose, indicating that the students understood who is affected by the issues they chose. In the chemistry course, students chose topics such as fertilizer usage (communicating to aquatic wildlife protection agencies and farmers); antibiotic resistance (communicating to soap manufacturers and the CDC); electronic waste recycling (communicating to electronics consumers and E-waste companies); and the impact of ADHD on studying (communicating to students diagnosed with ADHD and to a university student disability department). In the environmental engineering course, students discussed topics about clean water and water access rights both in the United States and in other countries, demonstrating their global considerations of socioscientific issues.

Successful outcomes of the assignment

This assignment was generally successful in achieving our goals of helping students think about inclusivity in science writing as well as practice peer review skills. One of the authors (AP) assessed the students’ work in the chemistry course using the USWR. Overall, we noted relative consistency between scores awarded by AP, a researcher trained in using the rubric, and the students’ scoring, suggesting that even at this novice level, the students are demonstrating some skills in peer review and accurate assessment of science writing quality.

After peer review, students edited their draft versions to create a final version. Although students only used the rubric to peer review and score their draft versions, author AP also scored the final versions. Of the eight final versions, six had higher scores for both final versions compared to the drafts, and two received the same scores for both versions. Overall, the increased scores between the drafts and the final versions indicated that the students learned how to respond to peer review and improve their scientific writing, which is another valuable

disciplinary skill.

After analysis, the scores from both AP and the students indicated that the students struggle to target specific audiences in their writing and to write uniquely to these different audiences. The scores awarded in the “targeting audience” category tended to be lower than those in other rubric categories. Although students struggled to write to unique audiences, they could recognize when the writing was not accurate for the audience. Even though our instruction in the classroom and the prompts in the Message Box encouraged targeting specific audiences, students need further practice in executing these skills. Improvement in the students’ ability to target their writing to different audiences could be reinforced through future iterations of training and practice. Thus, this assignment was successful in highlighting the status of student skills in targeting specific, unique audiences via science writing. The assignment provided some practice in this skill, but this assignment alone is not sufficient to totally teach this key skill.

Limitations of the assignment

The assignment is limited in that students are only writing one paragraph to each audience. If more time were allotted for the assignment within the semester, students could practice writing longer pieces to diverse audiences. The goal of the assignment was to focus on considering the perspectives of diverse groups and to practice outlining messages for them. As a modification of this assignment, students could easily expand these messages into longer writing pieces. In both the chemistry and environmental engineering courses, students utilized the skills developed in this initial assignment in longer writing pieces, as described below.

Future plans for the assignment

Throughout the semester in the chemistry writing course, author NL used the USWR for peer review on other assignments, including for standard lab report assignments and for a writing assignment aimed at a broad scientific audience. Throughout the semester in the environmental engineering course, students utilized the tenets of inclusive science communication and outlining with the Message Box in longer writing assignments about environmental justice issues.

Author NK is creating a scaffolded series of inclusive science communication training courses for STEM students. This assignment of inclusive science writing, intended to shape the students’ ability to write to different audiences, will be one of these trainings. We anticipate that students who receive prior training in inclusive science communication may be better equipped to target specific audiences in this assignment.

Use for other faculty

This multifaceted assignment—which involves considering inclusivity and social justice in science writing, targeting unique audiences, performing and responding to peer review, and utilizing published tools like the COMPASS Message Box and the Universal Science Writing Rubric—can be implemented in a diversity of courses. This could be implemented in content-heavy lecture courses, giving students a chance to not only learn to write but also write to learn the content (Balgopal et al., 2018). This could be implemented in laboratory courses, giving students a chance to discuss results from their experiments with different audiences. This could also be implemented, as we have done, in courses specifically focused on science writing or socio-scientific issues. The beauty of this assignment is that it can be adapted to any STEM discipline. Students can be asked to write about any socioscientific issues relevant to that discipline. While we used climate change as a starting point in the chemistry course and environmental justice as

a starting point in the environmental engineering course, a socioscientific issue relevant to any STEM discipline could be substituted. Other topics like mental health, personalized medicine, mathematical modeling of disease outbreaks, infrastructure issues, or vaccine hesitancy could be integrated into other STEM courses.

It is important to address the teaching portion—explaining inclusive science communication, the Message Box, and the USWR or other peer-review tool—before assigning students the writing portion. However, this can be done within one class period. This teaching provides students the needed guidance on social justice and inclusion in science writing as well as tools for outlining and assessing the quality of their messaging to two unique audiences in order to be successful on the assignment.

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ASSIGNMENT

Producing and Peer Reviewing Inclusive Science Writing about Socioscientific Issues

Learning objectives:

After this assignment, students will be able to:

1. Frame unique messages to two distinct audiences, taking into account their perspectives
2. Write about the intersection of science and social justice issues
3. Provide feedback on the quality of peer's writing
4. Improve their writing in response to peer feedback

Science communication can take many forms, from a deficit-based approach that speaks to the public as a non-informed monolith to a more inclusive approach that considers the perspectives of diverse audiences. Science writing is an important disciplinary STEM skill, but it often fails to be inclusive of diverse audiences, both in terms of diversity of identity as well as diversity of expertise. The goal of this assignment is to help you develop skills in producing inclusive science writing as well as assessing the quality of that writing via peer review.

In this assignment, you will consider a socioscientific issue that relates to what you have learned in your courses this year. Then, you will write about this topic via two short (~1 paragraph) essays to two different, unique audiences.

To outline your paragraph, utilize the COMPASS Message Box (*COMPASS: The Message Box Workbook*, n.d.). The Message Box helps you talk about an issue to a specific audience and consider why they care about the problem, how they can be involved in a solution, or how they will benefit from the solution. Think about the social justice ramifications of the socioscientific issue you are writing about and how diverse audiences may consider the issue from different angles.

After you write your paragraphs, you will be assigned a peer's writing to assess. You will utilize the Universal Science Writing Rubric (Pisano et al., 2021) for your peer review. This rubric

helps you focus on diverse rhetorical concerns – science content, interpretation of science content, targeting the audience, organization, and writing quality – so that you are not only focusing on surface features like grammar. Both the process of critically analyzing a peer’s writing as well as receiving feedback from a peer are important aspects of the scientific writing process.

Since targeting two unique audiences is a key focus of this assignment, utilize these questions to guide your rating of the targeting construct:

1. Did they utilize language that will be understandable by the specific audience?
2. Did they consider the perspectives of why this audience cares about the issue?
3. Did they consider the ways in which this audience can be involved in a solution, or barriers to their involvement in a solution?

Once you receive this peer review feedback, you will edit your paragraphs to produce final drafts.

Supplementary Material

For supplementary material accompanying this paper, including a PDF facsimile of the assignment description formatted as the author(s) presented it to students, please visit <https://doi.org/10.31719/pjaw.v7i2.156>.

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