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Abstract: *Drawing on interviews with nine graduate science students, this article explores perspectives on a Public Communication of Science (PCS) course designed to help students translate their research for a public talk given at a local town hall. I first outline the history of the student-run course and then discuss three course components—public rhetoric of science; improvisation; and audience awareness. Within each component, I describe one student's particular experience with the course. I describe how students transferred rhetorical lessons from the course to their academic writing but could also transfer rigid views of communication from their scientific work back into their public talks. I also argue that the PCS course helped students to embody flexible scientific identities, but also had the potential to alienate them from norms of communication in their field. Meanwhile, their strategies for imagining and speaking to the public remained constrained by limited access to a range of audience perspectives. Findings demonstrate that there is much to be gained in challenging science students to translate their findings for new audiences. At the same time, instructors must continue to think critically about how we can help students to imagine and access a range of publics.*

> *Part of the public communication training is thinking about who might encounter this and what preconceived notions are they probably going to have about me, and how do I want to change those. I mean in some ways, I'm trying to manipulate their idea of who and what a scientist is.*
>
> – Graduate Instructor Kara

In the above excerpt, Kara, a graduate student in Environmental Science who has been involved for several years as a designer and instructor for a graduate Public Communication of Science (PCS) course at a large public university, describes some of her aims when communicating her research publicly. Most notable is Kara's focus on identity. She recognizes how her position as a scientist might create a barrier between her and her listeners, but she also sees that barrier as malleable. While previous research on public science communication in graduate programs has provided programmatic and curricular overviews (i.e. Crone et al.; Druschke et al.), scholars have yet to address how participating in PCS courses impacts graduate science students' identity and agency during a critical moment in the development of their professional personas. This research can also help us to better understand undergraduate science student preparation for future scientific communication, inside the academy or beyond.

This article will explore perspectives on a graduate PCS course designed to support students in translating their research for a public talk given at town hall. I first outline the history of the student-run course and then discuss three course components—pub-

lic rhetoric of science; improvisation; and audience awareness. Within each component, I describe one student's particular experience with the course. I describe how students transferred rhetorical lessons from the course to their academic writing, but could also transfer rigid views of communication from their scientific work back into their public talks. I argue that the PCS course helped students to embody flexible scientific identities, but also had the potential to alienate them from norms of communication in their field. Meanwhile, their strategies for imagining and speaking to the public remained constrained by limited access to a range of audience perspectives.

Overall, this research has the potential to inform future initiatives to incorporate scaffolding for a public talk into undergraduate or graduate science training, whether through formal curriculum changes (Moskovitz; Rakedzon et al.) or extra-curricular programs (Crone et al.; Simpson et al.). These findings demonstrate that there is much to be gained in challenging science students to translate their findings for new audiences. At the same time, instructors must continue to think critically about how we can help students to imagine and access a range of publics.

Graduate Writing Pedagogy and the Public Communication of Science

Graduate school presents a period of significant identity transformation for many students. Transitioning from outsiders to insiders within disciplinary discourse communities often necessitates that they take up both the language and worldviews of their field. Several studies highlight the challenges students encounter when learning to write at the graduate level as well as the entanglements between writing and disciplinary enculturation (Berkenkotter, Huckin, and Ackerman; Colbeck). As graduate students progress in their programs, they often come to self-identify as scholars, simultaneously becoming distanced from the language and values of laypeople. Alternatively, they may fail to assimilate into disciplinary culture, which can be accompanied by academic failure as well (Gardner).

Recent years have seen an increased interest in the unique needs of graduate student writers and a variety of programs to provide support, from the dissertation boot camp to programs that position students as "ethnographers of the writing in their fields" (Sundstrom). These courses recognize that graduate students are often still novice writers, struggling to decode the obscure genres of academia and carrying unfounded assumptions that "writing up" their research should be a transparent process (Kamler and Thomson 1-14). Thus, many graduate writing courses endeavor to demystify the genres of academia—from the dissertation abstract to the scholarly article—with a rhetorical focus on audience, purpose, and disciplinary context (Kucan).

While challenges exist across disciplines, graduate students in the sciences face several unique hurdles. For one, scientific discourse is often characterized by rigid organization, nominalization, and passive voice, which scholars have aligned with ideological perspectives like objectivity and antagonistic stance, that allow little room for personal voice (Halliday and Martin). Meanwhile, the little (if any) feedback that students receive on their writing during their undergraduate studies often focuses primarily on grammar and form rather than larger rhetorical context and aims (Moskovitz). At the graduate

level, writing instruction frequently involves co-authoring articles with mentors, which may not occur until late in students' programs (Florence and Yore).

While there is little research on graduate students involved in public communication of science, Druschke et al.'s initiative is a notable exception. Their NSF-funded curriculum aimed to develop graduate science writers' rhetorical skills across scholarly and public genres. A challenge for participants in their program was "convinc[ing] their major professors that [writing] participation is a worthwhile investment of time and energy that would otherwise be spent directly on their scientific research" (11). Similarly, research on the identity negotiations of professional public science writers shows a dominant perception within scientific fields that public communication efforts are "not widely accepted as legitimate forms of scholarship" (Jacobson et al. 248).

Still, considerations about identity and public communication training are rarely a consideration for PCS education at the graduate level, even while there is a growing recognition that fewer doctorates than ever will move into tenure track research positions in the sciences. By considering both the affordances and limitations of students' experiences in this PCS course, I hope to inform future courses and programmatic design. On a broader level, ensuring that science students gain these skills early on in their careers can improve the public's access to and comprehension of scientific research in the future.

History of the PCS Course

The PCS course described in this article emerged out of a 2009 reading group organized by graduate science students across a range of disciplines to discuss several books on the topic. The group decided to launch a speaker series, where graduate students had an opportunity to share their work with interested audiences in a classroom on campus. During the initial 2010 speaker series, students recognized the difficulty of translating their research. Thus, several members spent the summer re-designing curriculum based on the shortcomings they observed in those initial presentations. The following year, the group piloted a three-credit PCS class that met for two hours weekly and was taught by several of the initial presenters. Course outcomes were described as:

1. To assist graduate students with developing skills to communicate with the public about science and engineering;

2. To provide opportunities for graduate students to present their area of research to the public; and

3. To promote public awareness of research conducted by graduate students at [the university] (Clarkson et al.).

The same year that the group first conceived of the PCS course, they also received city support to move the speaker series to a town hall, where it was more easily accessible to the public. The town hall is centrally located in an urban location and regularly hosts public readings, performances, and other cultural events. The science speaker series was held weekly, publicized as part of the town hall's monthly calendar, and free to attendees. During each event, two students would tell the story of their research alongside a Powerpoint for 20-25 minutes with time for questions at the end. The PCS class con-

tinued to run during Winter quarter for several years, taking applications each Fall and aiming to keep the incoming cohort to about 16 students. The course was volunteer-taught until 2013, when the leaders garnered college support to fund a TA. However, the group continued to grapple with institutional buy-in, struggling to find a department to list the course and to maintain funding for their instructor. As of this writing, the course is no longer being regularly offered.

Methods

Research for this project was undertaken over a ten-week quarter at a large, public Northwestern university in winter 2013. At the time, I was a graduate student in English with research interests in the rhetoric of science, participating in a certificate program in public scholarship. Through that program, I designed a project that involved talking with participants of the PCS course about their course experiences. I never took an instructional role in the course.

I conducted semi-structured interviews, ranging in length from twenty to sixty minutes with nine graduate science students involved in the course. Four interviewees were returning participants, taking leadership roles in the class, while five were new participants in the class. Five were female and four were male. They came from a wide range of majors including Astronomy, Forestry, Fisheries, Computer Science, Engineering, and Biology—a representative cross-section of the variety of majors who enrolled in the course. I also attended a class session that focused on improvisation and embodied performance as a limited participant and observer. This research was exempted by the Human Subjects review board at the university where it took place. All of my study participants have been given pseudonyms to protect their anonymity.

Three Graduate Student Experiences

In this section, I discuss three key components of the course—public rhetoric of science, improvisation, and audience awareness—and highlight the experience of a graduate student with each of these three components. Findings provide a glimpse of graduate students from a variety of backgrounds negotiating the complexity of public communication. Ultimately, their accounts offer insider perspectives on the unique identity negotiations at work for graduate students as they move across scholarly and public audiences.

Teaching Public Rhetoric of Science

In order to help participants translate their research for public audiences, the group taught general principles for public rhetoric of science, such as the use of narrative form and avoidance of field-specific terms. One key guideline in the course was using the narrative arc to tell the story of one's research. Three participants discussed a storyboarding activity they did in the class as an important transition point in thinking about organization of the narrative. Returning instructor Ben explained:

> [Participants] have little sheets of paper like notecards where they quickly write down what they want to present and then…they can move the notecards

> around and figure out how to put that into a form that would be easy for someone to follow.

The storyboarding activity encouraged participants to imagine themselves guiding audience members through a series of logical steps to help them arrive at the bigger stakes of their research. Given the emphasis on structure over content and context in their undergraduate learning, some participants described the narrative arc as just another formal constraint to be adopted without consideration of rhetorical aims. However, storyboarding pushed against this instinct and prompted students to think about logic and organization in relation to their audience.

Another course lesson in public rhetoric of science was the reduction of disciplinary specific jargon. Because its members represented a range of majors, the public communication class provided an opportunity for participants to get feedback on their language choices from those outside of their disciplines, which helped them to start recognizing insider knowledge more readily. Of course, with a class full of graduate student scientists, their understanding of a nonspecialist's prior knowledge of vocabulary was limited. For example, instructor Megan described one class period where the group struggled to discern whether the word "particle" was jargon: "It feels like everybody should know what a particle is but is that just because I'm a scientist? And all of us there, like nobody could really offer an unbiased opinion on that." This demonstrates how challenging it was for this group of students to distinguish between disciplinary jargon and common parlance.

Derek's Experience: PCS Lessons for Academic Writing

Derek was an Astronomy PhD student in the final year of his program and had been involved with the PCS course since its inception. As someone who intended to pursue a scientific research career, Derek was able to articulate how lessons from the PCS course were shaping his approach to academic writing, especially in thinking about the choices he made for his disciplinary audience. Like many of my participants, Derek received no training in scientific writing during his undergraduate career, and a discussion of writing came late even in his graduate work. He explained:

> I didn't start to get feedback on my writing until my third or fourth year of graduate school when I was writing my first scientific papers and my adviser had to go through those and iterate with me something that she felt like was acceptable to send to a journal.

In his final year of graduate school, however, he had begun working with a collaborator who was more heavy-handed with revisions. This was a common experience for my participants, who received thorough writing feedback from their advisors once they began to co-write articles. For Derek, his advisors' comments forced him to think more about things like paragraph structure and use of examples in his scientific writing. As he began to transition into professional communication in his field, Derek's perspective

on scientific writing became more nuanced, and he recognized opportunities for rhetorical decision-making.

This also translated into Derek's understanding of how the PCS course has impacted his scientific writing. He saw the biggest impact on how he writes introductions to research articles, which he initially saw as "daunting." Derek noted:

> I think [the class] really helped me in writing introductions to papers, I actually put a lot of thought into what makes things fit together well, what makes things easy to read or at least easy to understand.

Derek describes a transition from simply listing all research on a topic to thinking carefully about the connections between different authors and ideas to tell a fluid story. He addresses organization specifically, and audience needs more broadly, as shaping the choices he makes in authoring an introduction. Thus, his discussion indicates how practice with public communication has the potential to help both undergraduate and graduate students recognize and value relationships among content, organization, and audience that exist in their scholarly writing as well.

Improvisation: Countering Dominant Scientific Identities

During the class session that I attended, a female guest speaker who had a background in both Astronomy and Theater led the group of graduate scientists through a series of improvisational games and talked about her experiences with public performance. In one game we all stood in a circle and pretended to pass a large orb to the person next to us, developing a unique and funny motion for passing it. The game was highly physical and required participants to think on their feet but without much risk; most passes elicited a group laugh. All these components were in line with the goals of improvisation for the course as class leader Derek articulated them:

> I call it getting comfortable with being uncomfortable. I think that the improv, you make a fool of yourself and you start to realize that it's not the end of the world if people laugh at you.

During interviews, four students referenced improvisation, citing either specific games or "the improv stuff" (Megan) more generally, as shaping their understanding of public communication. In their accounts, improvisation created an opportunity to imagine space for play and misstep within their scientific work, an activity which impacted not just their ability to communicate but also their feelings about their role in the scientific community. Students saw scientific writing as formulaic and scientific identities as rigid and serious. Improvisation activities, then, were influential in helping students to imagine a new kind of scientific identity.

Several participants described the PCS course as a productive space to play with new orientations to their research and themselves. Or as Kara explained, improvisation games "force you to be silly and not take yourself seriously and sort of loosen up." Similarly, the public speaker in the class I observed described her interest in the PCS as driven in part by a need to take on a different kind of scientific persona than the one she

felt was available to her in the lab. She expressed her to desire to be feminine and "wear a dress" as a scientist, as well as to be able to leverage her love for theater and performance.

Megan's Experience: Incompatibility of PCS and a Research Career

Megan was a Fisheries student finishing her Master's thesis and interested in moving into a career in web design or public outreach for a scientific department or organization. Prior to graduate school, Megan had supported the online presence of both academic and research institutions, finding this to be an area with abundant opportunities because "most scientists are just very…anti-online anything." As one of the co-teachers for the PCS course in 2013, Megan positioned herself in opposition to scientific professionals, finding the world of scientific research to be stuffy and pretentious after her experiences with the course:

> I actually really hate hearing other science presentations now because I identify the jargon and I go 'Oh my god, you're just being an a**hole, you don't need to say that word.'

While her adviser was supportive of her public engagement activities, Megan still experienced what she described as a "cloak of shame" as a public communicator. This cloak was lifted when she ultimately decided to pursue a career outside of scientific research and began to publicize rather than hide her investment in public communication.

Megan saw the public communication career path as a natural outgrowth of her interest and motivation for becoming a scientist:

> The reason I got into science is because of feeling like science is under-represented in our country and the world and needs a voice […] I realized that you can't really do research and communication as well as you could just do communication, so because I liked communication more, I've kind of moved my career trajectory from going on to a PhD to just doing science communication.

The incompatibility that Megan describes here between research and communication was a common theme in her responses. She often articulated an impression from the scientific community that she could not be both a communicator and a scientist. Her shift in career goals enabled her to respond to them: "that's why I'm not going to be a scientist and a communicator, I'm just going to be a communicator."

This notion of incompatibility appeared in other students' responses as well. Similar to Megan, Rebecca described her ideal career as based in public communication, as "director of some type of science foundation," and when asked how research might fit into those career goals, she reflected: "I mean it would be cool to be able to do both but I haven't really found out where I would fit in with that." Three of the other students who were focused on scientific research careers saw public communication as an addendum that they would participate in when possible—doing public talks on the side or including a communication certificate on their resumes—but did not have a clear vision for how the two would be integrated in their careers. Kara, who was nearing the end of her PhD in Environmental and Forest Sciences and preparing to go on the academic job market, recognized that demands on her time early in her career would likely mean

that her main involvement in public communication initially might be "inspir[ing] more people to go out and communicate their science." However, post-tenure she saw the potential for recommitting to public communication efforts of her own.

Audience Awareness: Imagining a Listening Public

Just as public communication activities ask students to envision new identities for themselves as scientists, they also demand imagining an audience that is not necessarily familiar or accessible: the public. The graduate science students in this study had varying levels of engagement with publics outside the university depending on prior experiences—from Sue's participation in the Peace Corps to Derek's volunteer role with the local science museum. Thus, instructors focused on helping participants try to estimate their audience's interests and to adjust their talks accordingly. The challenge for both participants and instructors, however, was that they did not have access to feedback from the town hall audience prior to delivering their presentations. The primary source of public feedback in the PCS course was other course participants and instructors—all graduate science students.

One activity was a "cocktail party," in which participants assumed the role of guests. Instructor Megan explained that for homework students were asked to brainstorm possible attendees at the party for whom a presenter would need to tailor their delivery: "say you've got like a politician and an elementary school student and a retired engineer and a fisherman and…you actually think in detail about what that kind of person values and what their daily, day to day life is like." Within class, half of the students were scientists and the other half wore name-tags representing different kinds of audience members. Thus, the scientists had to consider how to explain their research to someone from this unique and specific background. This provided participants practice with the rhetorical flexibility needed to explain their research to a variety of listeners. Still, even while participants were able to recognize the importance of valuing an audience member's prior knowledge, this knowledge remained imagined.

Sue's Experience: Navigating Audience Assumptions

To envision her audience, Sue, a third-year PhD student studying prairie growth, drew on her experiences with public communication during her undergraduate studies and her time with the Peace Corps in Senegal. Working with a largely non-English speaking group with limited formal education, Sue had practiced translating her research into accessible terms:

> That was kind of the beginning of thinking like, "Okay how can I use simple words and how can I use concepts that any person can understand to [communicate my research]."

She also drew on her prior experiences with a community engaged project during her undergraduate work and a current citizen science collaboration to inform her view of an audience and goals for communication. In the context of her town hall presentation,

she articulated the necessity of making her research accessible yet challenging enough to keep her audience engaged:

> The ability to be tactful and not to talk down to anyone or to make people feel like they are part of the conversation rather than just being talked at, I think that's a universal thing.

Sue's emphasis on a conversation and valuing audience members' prior knowledge resonates with current scholarship arguing against a deficit model for public science communication (Perrault).

Still, the town hall presentation did not facilitate the kind of audience exchange that informed Sue's previous work with public outreach, so she had to make decisions about her presentation based on her approximation of audience experience. Overall, she worked from the assumption that "a lot of people don't even know that we have prairies in Western [State]." Building from that imagined audience knowledge, Sue decided to focus her town hall presentation "more broadly on what do prairies do for us and why are they important and why should we conserve them." While she planned to briefly mention the prairie species that she studies, the bulk of the presentation would focus on the big picture of prairie growth. In doing so, Sue still relied on generalizations about her audience's lack of familiarity with the topic garnered from lessons in the PCS course.

Meanwhile, Will, a PhD student in Astronomy who was finishing his dissertation, was more critical of the town hall presentation model for the class precisely because of its limited opportunities for exchange. Will had been involved with the PCS course from the beginning, and he noted how presenting in classrooms on campus had enabled a more authentic conversation with attendees. For him, the people who would attend a scientific town hall presentation or would go to a science museum were not his ideal audience because they were already convinced of the importance of science:

> Making more programs for under-served schools and targeting low-income, minority, and first-generation college or even high school graduates is kind of where I'd like to speak with the public.

Will sees engagement with these less accessible publics as precisely where we can "make the biggest difference" to promote larger societal change.

Conclusion

The range of student experiences shared here demonstrates both the strengths and potential pitfalls of a PCS course. While this was a graduate course, the analysis here may also apply to undergraduate pedagogical contexts. Students had the potential to transfer contextualized and audience-focused views of communication from the PCS course back to their scientific writing but could also carry rigid perspectives on writing from their scholarly work into their public communication. This points to the need for instructors to take a genre-based approach to teaching the formats of PCS—having stu-

dents examine multiple presentations with different approaches to create a list of shared features and places for creativity and innovation (Devitt).

In addition, the PCS course offered students alternative visions of who a scientist could be that both extended the range of possible identities available to them but also potentially alienated them from norms of communication in their field, even to the point where they might decide to change fields altogether. Given that women have been over-represented in PCS and under-represented in scientific leadership (De Welde, Laursen, and Thiry), Megan's is a troubling perspective that needs to be addressed by instructors of PCS courses. PCS instructors might consider activities that allow students practice with shifting their self-presentations, such as preparing cover letters, resumes, and personal websites that target a range of career paths, and bringing in speakers that represent a variety of career trajectories and possibilities.

Finally, students drew on diverse experiences with public engagement to imagine the public, but their presentations remained constrained by limited access to the specific audience that attended their talks. An activity like the cocktail party, for example, might benefit from better grounding in qualitative research to include interviews and observations. This might take the form of textual research, like reading blog entries by a local politician, or fieldwork, like calling an uncle who is a lawyer to talk about what might interest him about astronomy. In addition, instructors and leaders need to devote class time to discussing Will's concerns—questions about equity of access to public science talks and strategies for speaking to out-of-reach audiences who do not necessarily prioritize or seek out science.

The success and longevity of this course points to the value of letting graduate student interest and enthusiasm for public communication serve as the driving force behind future curriculum. Still, this article demonstrates that both undergraduate and graduate-level educational programs in PCS should be viewed with a nuanced and critical eye towards their benefits and risks for students and the public, including alienation from field-specific norms of communication and limited views of what constitutes a public and how they might be swayed. Overall, PCS courses can serve as a fruitful site for collaboration between writing and science scholars as it continues to grow as an area of teaching and research. On the other hand, if we continue to train scientists whose primary objective is communicating with their own niche disciplines, we limit both their future career opportunities and more importantly, we limit public access to, comprehension of, and trust in scientific information.

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