

Communicating nanoscience and the communication center: An INNOVATE case study

Kimberly M. Cuny
University of North Carolina at Greensboro

Erin D. Ellis-Harrison
University of North Carolina at Greensboro

Taylor L. Williams
University of North Carolina at Greensboro

Introduction

In his 2016 book chapter, Herr adamantly argues for transdisciplinary environments as an important change to the education of science students. Herr, as director of the Nanoscience department at the Joint School of Nanoscience and Nanoengineering (JSNN), writes extensively of educational environments as ecosystems with educational supply chains. He introduces STEAM+ explaining that the A added to STEM represents art and this STEAM+ is helping (Herr, 2016):

prepare students for careers that value creativity and innovation. It thrives on hands-on problem solving, critical thinking and communication skills. It also stimulates the discovery, understanding, application, integration, implications and communication of extremely small nano-materials and nanoscopic processes for future nanotechnologies that will benefit society and address global challenges. (p.85)

As has been the case with much of our innovation, The University Speaking Center at The University of North Carolina at Greensboro (UNCG) is engaged in communicating science work because it is what our campus community has brought to us.

A few years back, UNCG biologist, Bruce Kirchoff approached Cuny, our director, seeking a formal professional

relationship which included his developing and facilitating programming similar to what he attended at the Alan Alda Center for Communicating Science. That led to the development of a faculty fellowship, with no formal compensation attached, for Kirchoff. In that role, he has intentionally added improv and storytelling to our center's offerings, cultivated a science community audience for our communicating science programming, developed our programming to support graduate students doing both the three minute speech and poster presentations, supported our INNOVATE internal grant funded efforts, presented on academic panels, and more recently, contributed to the scholarly body of this work.

Soon after Kirchoff joined us, Herr sought to partner to add A/art to the education of his first-year graduate students. Herr's students at the JSNN are also our UNCG students as a result of a UNCG partnership with nearby North Carolina Agricultural and Technological State University. Herr previously visited the Alda Center. In working with Herr's students, we have drawn upon theatre and communication studies to add the art that Lindenfeld writes about. This art provides a genuine connection where "we are willing to listen with the willingness to be changed, the moment of thoughtful risk taking, of emotional vulnerability that can open up possibilities for creativity and change" (Lindenfeld, 2018, p. 9). We also agree with

Jackson, writing from his role of President of the National Communication Association, “that our field has something valuable to add to the way in which science is understood by our world” (2018, p. 2).

In 2018, Cuny, Harrison, and Williams were joined by Kirchoff on a communicating science panel at the 17th Annual Excellence at the Center conference. The panel garnered a great deal of questions and discussion which continued throughout the rest of the conference. We were encouraged then to further share our UNCG internal INNOVATE grant funded efforts. We put ourselves in the middle of this case study, because we have done the work ourselves and so we are in many ways telling our own stories. We believe that doing this work adds great value to scientific inquiry and innovation. While this case study adds to both communication center knowledge and the knowledge of communicating science, we offer it with hope that other centers will look to replicate our programming where they can. To that end, we have taken the time to provide great detail. We present a bit of background before details then close with lessons learned and questions to consider.

Background

Our nanoscience support is a direct product of our cultivating relationships with science faculty. Williams initially met Herr during the Spring 2016 semester. Williams, was enrolled in a graduate level communication studies course titled, *Communicating Health & Science*. The professor of this course had previously attended a summer seminar with Herr and others from UNCG, at Stony Brook University’s Alda Center. Thus, part of the course was dedicated to communicate scientific research as it was taught at the Alda Center.

Students enrolled in the communication course took a tour of the JSNN facility conducted by Herr who shared stories of research achievements and projects currently in progress. Later in the semester, the students co-designed then co-facilitated an all-day workshop for Herr’s nanoscience graduate students. The goal of this workshop was to help the nanoscience students better communicate their research to non-science audiences. To accomplish this goal, the workshop was comprised of instructional seminars on public speaking strategies and the facilitation of whole group improvisational exercises. Students enrolled learned that only those who are trained to do the work as they were, can support scientists as communicators. The course has since been offered again with a similar co-designed and co-facilitated workshop at JSNN.

In 2016, Bruce Kirchoff approached Cuny, our director, to inquire about ways to work together in providing local scientists with oral communication training. Kirchoff, an award winning Professor of Biology at UNCG, had formally studied scientific communication at the Alda Center. As a result, Kirchoff joined the speaking center as a faculty fellow and the center at UNCG started to offer communicating science programming to local scientists.

Herr and Williams maintained a working relationship that found them meeting during the summer of 2017 to discuss potential projects to support JSNN students with their development of communication competencies. Williams referred Herr to the UNCG Speaking Center where she had fulfilled her graduate assistant responsibilities during the school year. Williams also agreed to do an oral communication workshop for science high school students at JSNN that summer and later formerly connected Herr with Cuny.

Initial Access to Nanoscience

Students. In the fall of 2017 Herr invited the speaking center to visit his NAN 622 first year graduate class to talk about the center's services. NAN 622 is a two credit professional development course which spans two semesters. As the students enrolled would soon be giving speeches in class, the initial intention was to introduce this important support service. Orientation speeches presented by this speaking center have the primary goal of introducing students to the speechmaking process with a secondary goal of understanding how the center can support student-speakers throughout their process. These goals are normally met by way of a fun interactive activity, designed by Cuny, which gets students up on their feet and talking with one another. Herr wanted more. He also wanted us to provide an opportunity for the students to practice informal speaking and get to know one another. He was looking for arts programming more in-line with what he had experienced at the Alan Alda Center where programming draws "on the passion, creativity, and vulnerability of the theatre arts" (Lindenfeld, 2018). A narrative account of what was developed and presented is available [here](#).

Providing Support to Science

Graduate Students. As a result of this success, Herr invited the center back to provide instruction to support the individual speeches they would be giving after fall break. This time Miranda Tonkins, center graduate consultant, joined Cuny as they took the opportunity to review some of our [tip sheets on organizing an informative speech](#). At the close, some students requested appointments for online consultation support. These sessions would have to take place during fall break as speeches would start as soon as they

returned. Tonkins immediately made herself available for these fall break seasons.

At around the same time, Kirchoff and Cuny started coaching a handful of science and nanoscience graduate students from both UNCG and JSNN in preparation for UNCG's officially registered three-minute thesis (3MT) competition. The nanoscience students who were coached by Cuny further practiced and received feedback from the undergraduate consultants at the speaking center while Kirchoff further coached one of the biology students.

For the past five years, Harrison had been a judge for the UNCG 3MT competition sponsored by the graduate school. At UNCG, there are two preliminary rounds before the final 10 contestants present their 3MT to the faculty, administrators, and the general public. The winners are selected by a panel of judges that usually consisted of a few faculty members across different disciplines and members of upper administration, both on campus and within the university system. Harrison was a judge for the final round in one year and was a judge in the first and/or second preliminary rounds for the other four years. Judges used the official 3MT rubric created by the University of Queensland and added written feedback for each contestant. Harrison's experience with the 3MT competition gave her the knowledge on what winning presentations looked and sounded like. For the most part, the winning speeches had a metaphor and a story.

In the fall of 2017, Harrison served as a judge for the last time. She was not made aware of Kirchoff and Cuny's coaching efforts nor the 3MT student's speaking center visits. One of the students they coached won the competition. In the spring semester of 2018, Harrison used her knowledge of the 3MT competition to aid second and third year nanoscience graduate students in an in-class mock 3MT to help

them refine their research proposals and communicate their message clearly to a general audience. In the fall of 2018 Kirchoff, Harrison, and Cuny provided a 3MT workshop sponsored by the graduate school and attended by around ten competitors. Six of the attendees arranged for coaching sessions with Harrison, Cuny, and two graduate assistants working at our center.

Seeking Grants with Science Faculty. Also in fall 2018, faculty at JSNN invited Cuny to join teams seeking multiple high profile scientific grants designed to change the way graduate students are trained. For the most part, the grants sought large amounts of funding for science with oral communication serving as what Berube (2018) calls window dressing. Throughout the academic year, Cuny accepted 5 invitations to join grant teams. JSNN faculty always positioned her as Co-Principal Investigator which Berube recommends.

In December, the speaking center joined JSNN faculty in seeking INNOVATE seed monies from the university. This application was specifically for research which called for the design and implementation of radical speaking center pedagogy that would include capturing students' presentations pre and post coaching and culminate with a workshop open to all local scientists. Unlike the national science grants the team sought after, communication was the focus not the window dressing. This project's funding sought to gain release time for speaking center faculty, Cuny and Harrison, funds for Williams to coach JSNN students and serve as a research associate, and stipends for workshop guest speakers, David Berube and Kirchoff. The INNOVATE Grant proposal was funded, however the budget was cut. A small amount of Speaking Center funding was used to supplement the lost dollars.

Work was scheduled to begin at the start of the spring semester ending in May.

INNOVATE funded case Projects

During the spring semester, the speaking center developed and supported eight INNOVATE funded projects and one additional project for second year nanoscience graduate students. They were a 1) symposium which established credibility, 2) in-class instructional/workshops for Herr's professional development class, 3) Let's Talk conversation practice, 4) coaching sessions, 5) in-classroom evaluation of student speeches, 6) workshop and assessment support for a second class of nanoscience students, 7) INNOVATE half day workshop program, and 8) Outside (third-party) assessment of student's pre and post coaching presentation. Each is discussed in the following sections.

Symposium

Cuny, Harrison, and Williams were scheduled to be the first speakers of JSNN's weekly Friday afternoon symposium for the spring semester. Ordinarily the speakers are scientists who come to speak about their research. These presentations are generally neither dynamic or engaging as the focus of the speaker is on information dissemination over audience interest or engagement. Our billing caused a disruption to that. As nanoscience and nanoengineering students at JSNN are very global, it was reported by JSNN faculty that the students were not communicating either socially or in the classroom with people who were dissimilar to themselves. We were charged with helping the JSNN students to communicate across cultures. Herr wanted Art to be a part of the presentation and we would need to introduce our bigger INNOVATE plans.

We were told to expect 80 participants and so we numbered index cards

1 to 80 shuffled them and waited at the two entrance doors. As students entered the large lecture hall, we handed them each a note card and told them to sit in numerical order with 1 at the front and 80 in the back. This caused students to sit next to people who they would not normally sit next to. After a quick introduction to our INNOVATE plans we facilitated a bigger version of the science story activity [facilitated previously](#). This time, students would share their “My Science Story” with a neighbor then share again with a neighboring pair to create groups of 4. We debriefed with discussion questions at the end. Some tensions arose as one American student spoke out against “internationals” serving as science teachers pointing to poor communication competencies. We would shut this argument down later in smaller groups, after getting some context from Herr.

This was a successful symposium as we got students to speak with people they would not ordinarily approach, established a strong ethos for those who did not already know us, introduced the grant, and for the most part, enjoyed ourselves. The room had over 200 seats, we should have instructed students entering the room that 1 was at the front of the room and 80 was in the middle. Not doing so caused us to have to speak to the whole room. It would have been easier to project and move about half of the room.

In-class instruction/workshops for first year PhD students

Cuny, Harrison, and Williams provided interactive workshops for Herr’s NAN 622 class on February 9th and 16th to help them prepare for their in-class team teaching assignment. The assignment was loosely structured. Students had the freedom to choose how to present the information, what supporting materials to include, and what (if any) visuals to use. Students were

assigned their topic and their team of two or three people by Herr. We facilitated two different workshops during regular class meeting times. Each was designed to help students prepare for this assignment. The details of these workshops are available [here](#).

Let’s Talk

Williams and Cuny launched “Let’s Talk: Science Edition” in February 2018. This hour-long programming ran on a weekly basis in a JSNN classroom. All students at JSNN were welcomed to attend, regardless of their academic status or field of science. In total, seven sessions were facilitated throughout the spring semester. This program was modeled after [a similar program](#) for non-native English speakers provided by the Speaking Center on our main campus. The primary goal of the original program is to provide opportunities to interact with others and practice communication skills in a comfortable and fun environment. Borrowing from training and development practices, this is accomplished by starting the development process with intentional behavioral objectives to be met. The format of the session is first, each individual shares their good news, next we provide a bit of instruction which introduces the oral communication competency of focus. This is followed by one or more activities designed to give the participants an opportunity to try out the competency while the facilitators observe whether their behavioral objective(s) for the session is being met. Debriefing open-ended discussion questions are facilitated before we end with a quick improv game.

Let’s Talk: Science Edition. The goal was the same but the execution was different because Herr wanted more art and

Williams wanted to try some new approaches. Like the other Let's Talk program, undergraduates from our center regularly participated in the activities. At the beginning of each session, the desks and chairs in the classroom would be arranged in a U-shape design. This arrangement was intentional to support and encourage inclusive discussion among participants. A sign in was circulated and participants were welcomed to the program. After the introduction, an overview was provided and the one-hour programming would begin.

At the request of Herr, the first 3 sessions focused on discussing science heroes. Participants were instructed to introduce a scientist and shared how the scientist greatly influenced their own research. Some came prepared instead to discuss a scientist's research, we made this work for the activity. The following week, participants discussed a different scientist or research project that greatly influences their own research. The third session asked participants to consider themselves as science heroes and discuss their own research. We would shift to improv games next. A detailed account of what we covered is archived [here](#).

The Focus Group. The final Let's Talk: Science Edition session for the semester took place on April 13th, 2018. Williams decided to facilitate a focus group discussion. By this point, we had 4-7 participants who regularly attended the sessions and would have valuable feedback to offer. They came because their faculty research advisor required it of them. Williams' goal was to share the voices of participants during a panel presentation at the 2018 National Association of Communication Centers conference the following week. After the traditional welcome message and overview, Williams sat at the front of the room and began to ask

questions. As participants shared their feedback, Williams wrote down their responses. Williams and Cuny would also contribute their experiences and insights to conversation.

One participant expressed that he regularly attended the weekly program because he really appreciated the human connection that took place. When asked, "What was one takeaway from these sessions?", one participant responded, "Humans are the only intellectual beings that are hindered by their communication." Participants also offered topic suggestions for future sessions, such as an anti-jargon session or a science identity session. One participant suggested focusing each session on specific communication competency, such as vocal rate, then provide brief instruction on said competency and use it as a theme for an activity. For example, if vocal rate is the theme for a session, then participants could practice varying their vocal rate while reading a news article about science. Ironically, this is how we organize our original Let's Talk sessions for non-native speakers. Finally, one endearing remark came from a participant who could never remember the program's name so he would refer to it as "speech therapy."

Coaching Sessions

In March, Williams began meeting with student groups to further support the development of their group teaching presentations. These meetings were called coaching sessions. These sessions were conducted like traditional speaking center consultations in that the teams would discuss where they were in the speech-making progress and receive feedback on how to improve and progress towards the final presentation. However, they were considered coaching sessions because Williams had prior knowledge of the group

assignment and developed relationships with the speakers due to previous experience with them in the classroom. As coach, Williams could then provide more individualized attention and support to each group than she would in traditional Speaking Center consultations. Each group met with Williams twice to experience two types of coaching sessions: 1) [organizational coaching sessions](#), and 2) [practice coaching sessions](#). Each group was required to attend both coaching sessions before delivering their final presentation for the class.

In-classroom evaluation of first year student group presentations

Group presentations began mid-semester and followed a routine structure. One group was scheduled to present each week for the remainder of the semester. Herr began class with a few brief announcements. During this time, Cuny, and Harrison distributed NCA Competent Speaker Rubrics to all members of the audience including Herr, Cuny, Harrison and Williams. Williams would set-up the video recording equipment at the back of the room.

Once the announcements concluded, Herr called the group scheduled to the front of the room. After a few adjustments with visual aids or speaker notes, the group members would begin their presentation. [Immediacy behaviors](#) were a large part of the in-class workshops offered previously. We saw the impact of this learning in a few presentations. On two occasions, a group arrived early on their presentation day and rearranged the desks to increase the immediacy of the space. These group members stood to the side of the room during announcements.

During the presentation, audience members took notes on their evaluation forms and demonstrated nonverbal behaviors of active listening (i.e. forward

lean, head nodding, open posture, etc.). By the end of the presentation, audience members applauded and finalized their comments for the evaluation forms. Cuny, Harrison, and Williams collected the evaluation forms and Herr dismissed the class.

After each group presented, the group members received a self-reflection form and were asked to evaluate their own performance after the videos were shared with them. This form was different from the audience's evaluation form, but both forms addressed similar topics regarding organization and delivery of the presentation. Group members submitted the self-evaluation the following week, at the start of class.

In-classroom Workshop and/or assessment support for second year students

As a result of the work we were doing for the INNOVATE grant, the Director of Nanoscience Graduate Studies at JSNN asked Harrison to come to her class and help her second- and third-year graduate students to convey their research proposals to a general audience. While not funded, we accepted this invitation because the speaking center entertains in-classroom oral communication workshop requests from faculty. The request here was for Harrison to come to the class two different weeks to work with students crafting a three-minute presentation of their research and give a preliminary assessment of their presentation using the official 3MT rubric originated by the University of Queensland. Harrison was very familiar with this rubric from serving as a judge on campus. Students were to create one PowerPoint slide to accompany their presentation based on the guidelines set by the 3MT competition. In the end, Harrison did not exactly provide

instructional workshops but she did provide feedback and evaluation as instruction.

The first visit Harrison made to the second year class was on March 22 when seven of the nine students were to give their three-minute presentation. Students were to discuss what their research was, why it is important to study, and the potential science breakthrough and commercial impact. Harrison served as a judge as she timed the students and gave them scores based on the rubric. She discussed her score and gave feedback to students based on their first presentation. Harrison came back to the class the week of March 29 to again assess the student presentations and see if there were any improvements from the previous week. Harrison also had students fill out the rubric for their classmates to offer peer feedback as well. The third visit occurred on April 5 where Harrison provided a workshop on effective delivery competencies based on the areas that students needed to improve after viewing their presentation skills the previous two weeks.

INNOVATE half day Workshop

Results of the UNCG INNOVATE funded research were shared with students, staff, campus administrators, and the general public on June 11. The morning started with a welcome from the nanoscience graduate program director followed by an hour long presentation on the public perception of science from David Berubea of North Carolina State University. Next Cuny shared an overview of the project, followed by Williams who shared her coaching process, and Harrison shared the empirical results of the semester long training program.

After lunch, Kirchoff then facilitated a two-part Communicating Science workshop in which participants dissected 3MT presentations and applied the 3MT format. In doing so, they were asked to identify the goal of each of the three

minutes. Students conclude that the first minute is the introduction which must include the thesis and maybe a “hook” to get the audience to keep listening, the second minute is for materials and methods and maybe results, the last minute is to restate the thesis and give the audience an understanding as to why they should care about the research. The workshop is focused on the importance of connecting with one's audience. It includes ideas about the use of a single image slide and concludes with students getting the chance to present their own speeches with image and gain feedback from the speaking center professionals on hand and whole group.

An interactive discussion followed about how to engage with public audiences and best practices for use in different communication methods. Nanoscience PhD students also shared their testimonials after completing the semester long interactive training program part of the INNOVATE grant. Faculty from nanoscience discussed the next steps of the grant and collaborations with the Speaking Center at the conclusion.

Outside (third-party) Assessment

At the end of the semester, Harrison trained outside evaluators to assess student speeches. Speaking center student-staff members that worked during the first summer school session of 2018 were selected as evaluators for student speeches as they were not part of the work done with the JSNN students in Herr's NAN 622. The evaluators were comprised of four students who identify as female and one who identifies as male; both undergraduate and graduate students. Harrison taught Corey Bussiere, the most senior staff member, how to evaluate a speech using the National Communication Association's Competent Speaker Speech Evaluation Form which is essentially a rubric, explanation of each competency and the rating system, historical

importance of the rubric, and gave sample videos of college students team-teaching which was very similar to the assignment in NAN 622. In addition to working at the Speaking Center as an undergraduate consultant, Bussiere had just completed his first year in the Communication Studies master's program where he had an assistantship that found him both teaching the basic Communication Studies course as a teaching assistant (TA) and working at the Speaking Center as a graduate assistant (GA).

Harrison and Bussiere taught the other four evaluators how to evaluate speeches using the rubric and viewed sample speeches together. Once Harrison believed that the staff could evaluate speeches, she allowed evaluators to start viewing the presentations. They did this alone in a private consultation room. The student videos were stored in Harrison's google drive account so she would send one video (practice followed by final) at a time to each evaluator.

Assessment Begins. Staff members started viewing speeches on May 23 and ended on June 5. There was a total of six hours of viewing for each evaluator: one 30 minute practice session and one 30 minute final presentation. Evaluators were instructed to select one group at a time and watch their practice session first immediately followed by the final presentation in a private room with no distractions. They were instructed not to talk to any other person about the practice or final presentation videos until everyone watched them all. Evaluators were given one rubric per team member, per session which yielded a total of four rubrics for teams of two and six rubrics for the team of three.

Each set of rubrics was turned into Harrison after viewing a practice and final presentation.

The National Communication Association's Competent Speaker Speech Evaluation Form is broken into eight competencies with three ratings for each competency: unsatisfactory, satisfactory, excellent (2007). Each rating was assigned a point value with one point as unsatisfactory, three points as satisfactory, and five points as excellent. The form is intended for individual speech presentations. We adjusted for the team effort. When evaluating the groups, team members received the same score for competencies one and four while competencies two, three, five, six, seven, and eight were individual scores. Team members would have the same score for competencies one and four, but potentially different scores for the other competencies. The evaluation process yielded individual totals and an overall group total calculated by combining the scores from all team member's competencies.

An Excel spreadsheet was created to record the scores for the eight competencies, the numerical change between individual practice speech score and final speech score, and the numerical change between the group practice speech score and the final presentation score.

Five evaluators, eight categories, and five points maximum in any competency equaled 200 points as the highest score an individual could earn. The maximum score a group of two could earn was 400 points and a group of three up to 600 points. Table 1.0 shows the scores each student received and the overall changes in their individual and group scores.

Table 1: Individual and Group Evaluation Scores

Student	Individual Practice Score	Individual Final Score	Individual Change	Group Practice Score	Group Final Score	Group Change
1	136	148	+12			
2	166	178	+12			
1+2				302 (136+166)	326 (148+178)	+24
3	138	158	+20			
4	118	142	+24			
3+4				256 (138+118)	300 (158+142)	+44
5	148	148	0			
6	158	164	+6			
				306 (148+158)	312 (148+164)	+6
7	144	158	+14			
8	140	160	+20			
				284 (144+140)	318 (158+160)	+34
S9	152	164	+12			
S10	136	144	+8			
S11	156	162	+6			
				444 (152+136+156)	470 (164+144+162)	+26

Lessons Learned and Recommendations

We could not do this work without the partnerships and trust of scientists. As communication center nanoscience pioneers,

our learning curve is huge. The work we have been asked to do is not always a clear match for our mission yet we try to find ways to do it as faculty with our own

research interests. We share our biggest take-aways in hopes that this will be of use to others that seek to do this work or find themselves being asked to do it. For those who wish to do this work, one cannot hesitate when asked to participate. As one develops their ethos for doing this work on campus, they will likely be asked to do more. When working to support classes, get the full course calendar ahead of time and start working with faculty early to generate detailed speaking assignments with scaffolded elements.

Strive for each nanoscience student to establish one or two observable and measurable goals early in the programming, then require the nanoscience student to track their progress throughout the programming. We recommend starting with a single competency such as a reducing verbal fillers or nonverbal adaptors, incorporating movement around the room, or speaking at an appropriate volume. Schedule small amount of time, 5-10 minutes, for nanoscience students to write reflections of their progress or discuss their experiences with other students. Even though goals were established during the coaching sessions, there was not a lot of opportunity to revisit the goals that were set. This practice of intentionally tracking and reflecting communication goals will better illustrate the process of developing one's communication confidence and competence; it is an on-going process and the process is different for everyone. Furthermore, these goals need to stay minimal and could help focus the coaching sessions. At times, Williams's feedback during the coaching sessions involved several communication concepts and had a tendency to overwhelm some nanoscience students.

When working with members of the nanoscience community, make attempts to showcase the research of communication and share how certain communication

principles came to be. The majority of the NAN 622 students approached the communication workshops, activities, and coaching session in an academic and curious manner. NAN 622 students respected the work of the UNCG Speaking Center as well as the information that was provided. For example, one of the early workshops focused on ways to manage public speaking anxiety. The UNCG facilitators orally cited McCroskey's research on Communication Apprehension and noted Dwyer's related research while also highlighting her communication center director role. During coaching sessions, Williams supported her feedback to NAN 622 with communication center research. When discussing the importance of upright posture, Williams mention the benefit of opening up the chest to have access to more air which supported a speaker's volume. Also, how posture is an indicator of a speaker's confidence. In addition to the explanation, Williams demonstrated how these communication principles worked. Interweaving these research concepts into the program likely helped nanoscience students embrace the instruction and feedback provided. Ultimately, it seemed to resonate with the student's scientist identity and helped the UNCG facilitator meet the NAN 622 students where they were at. Furthermore, the non-native English speakers seemed to be the more invested and eager to reach their public speaking goals. Overall, we found this population more receptive to research aspects of communication than the majority of traditional college students we work with.

Find a bench scientist on your campus, like Kirchoff, who will join in your efforts to cultivate a communicating science program at your institution. We will next find ways to write more specifically about our relationship with Kirchoff. Consider launching a Faculty Fellows program at your center to institutionalize such efforts. Write

your faculty fellow an appointment letter every year and send a copy directly to that person's department chair, head, or director.

While the radical pedagogy of communication centers is well suited for this work, directors without improv training will need to gain it as Williams did in her graduate course. Others might consider partnering with theatre faculty or graduate students who have improv expertise because the art aspect of communicating science work is rooted in the humanities and connections made through improv. We agree with Lindenfeld that improv "may provide the possibilities as an artform when other forms of engagement fail" (2018, p. 13). Directors also need to keep an eye on finding meaningful ways to add the science of communicating science to this work. We suggest consulting literature from cognitive psychology. One year after INNOVATE, we submitted an NSF grant application which includes adding another of our faculty fellows, Roy Schwartzman from communication studies to the team. If funded, Schwartzman's social science research into the public's perception of scientists will add great value to our overall efforts and strengthen our communicating science ethos both on campus and across the country.

If asked to join a grant team for communicating science, be ready for some late night grant editing as most scientists keep long hours. After being awarded a grant, compare grant proposal budgets submitted with what is awarded right away. If you see cuts in the budget make adjustments to your plan immediately. Finally, invite your direct report to the final presentation of research findings.

Other lessons learned come from selecting evaluators and the video viewing process. In the case study, evaluators were mostly undergrads with one graduate student; all with little to no classroom

teaching experience. If replicated, we suggest that only graduate teaching assistants with experience teaching a basic course, evaluate videos because they would have seen or participated in a team teaching lesson before and have firsthand experience with those that are successful. As students get into graduate school and have smaller classes, team teaching is more common so having graduate teaching assistants view videos would be optimal. Also, evaluators would have more consistency in how they viewed the videos. Some evaluators might watch a video and then need to stop to take a consultation or might leave for the day so there were some breaks in watching the pre and post videos at times. These breaks should be eliminated if possible so that there is continuous viewing of one set of videos.

Conclusion

While we completed a large variety of communicating science work in just one year there is much still to be done, knowledge to be developed, hypotheses to be tested, and best practices to be identified. For those who wish to enter into this area of support, we have suggestions and questions to consider. Start by identifying what relationships your communication center already has with science on your campus and seek to understand how you can best leverage the relationships. If you cannot identify any such relationships, what is the best path towards forging a new relationship with a scientist on your campus? Can you bring Alan Alda to campus and create a spark? How can you find funding for that? Does your campus have a program that invites high profile outside speakers, who can you speak with from that program? What ideas do you have for the best ways to start supporting science students in their 3MT efforts on campus? How will you get buy-in from the sciences? Cormick (2019)

stresses the importance of formerly evaluating communicating science efforts. How will you do that? The NSF already sees value in funding this type of work. Who would be on the best team can you assemble on your campus to do this work? Do you have faculty that already received NSF funding? How can your communication center add communicating science to their current projects? Does your science, engineering, medical, or nursing school need their own communication center? Who do you need to talk to about making that a future grant funded project?

Communication centers entering this interdisciplinary field, working intentionally with local scientists, provide hope for a future where scientists solve problems, the public listens to them, and science denial is put to rest. We believe that this can be done only after scientists willingly engage in the art and science of communicating science training like that which we spell out here. This is a true growth area for the communication center community.

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