

Can a National Network of Undergraduate Research Program Directors Validate a Set of Professional Skills-Building Science Communication Workshops?

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ABSTRACT

This paper reports on the progress of an ongoing strategy for dissemination of a set of science communication workshops targeted to students participating in undergraduate research experiences on university campuses. Previous MRS Proceedings papers by the first author and collaborators focused on (1) the development and validation of the REU Science Communication Workshop (REU SCW) model through iterative practice, research and evaluation between 2005 and 2009, and (2) the 2012 testing of a scaffolded and piggybacked "beyond train-the-trainer" mode of dissemination of the REU SCW model to multiple university campuses, as compared to a highly-validated but less efficient one-to-one transfer process deployed between Boston and Madison between 2010 and 2012. This new paper reports on the follow-up effort to confirm and validate the success of the REU SCW workshop model as implemented at the second-wave of dissemination sites by the new cohort of participating undergraduate research program directors. We analyze data gathered in 2013 and 2014 from the participating students, faculty, and providers. The results indicate that the second-wave providers were able to reproduce the successful results achieved at the origination and first dissemination sites, and that providers and stakeholders at these additional sites value the model enough to continue providing it and in some cases to laterally expand it to other programs on campus. These findings suggest that it is possible to greatly expand the number of undergraduate research experience students receiving quality coaching in professional science communication skills by providing their program directors with a comprehensive professional development experience, employing the scaffolded, piggybacked, "beyond train-the-trainer" professional development model.

INTRODUCTION

In 2005, the Museum of Science (MOS) Strategic Projects team began working with university faculty associated with two NSF-funded research centers [1] to design and implement a professional development workshop program in science communication for participants in 2-3 month research experience undergraduate programs (REU). A key intent of REU programs is to recruit and prepare students for graduate school in STEM fields; therefore, a key goal of the REU Science Communication Workshop (SCW) program was to build student research presentation skills and confidence that would lead to success in the REU program and to further research endeavors, and also to build students confidence in communicating about their research with potentially-supportive but non-science-oriented peers, family, and community members. After years of iterative development and evaluation, a two-session REU Science Communication Workshop (REU SCW) model emerged that proved highly effective with students and also much appreciated by REU program faculty mentors, who noticed significant gains not only in student communication competence, but also in the depth of their understanding of the broader context and motivation for their research, another key learning objective of the REU SCW model [2].

The abundance of REU programs, including those sponsored by the National Science Foundation, together with the relative uniformity of REU program structures nationwide, make them a promising target for broader dissemination of the REU SCW model developed in Boston, potentially benefitting far greater numbers of undergraduates at a critical decision stage in their education and career tracks. With backing from the NSF Nanoscale Informal Science Education Network, the MOS team sought to investigate whether the REU Science Communication Workshop model could be disseminated successfully to other campuses.

The first dissemination method proved successful. This was a direct one-to-one transfer: the MOS team traveled twice to the University of Wisconsin-Madison campus during the summer of 2010 to brief NSEC and MRSEC REU program faculty mentors and to provide the two workshop sessions. The following year the Madison REU director, Andrew Greenberg, took over implementation of the workshop sessions, coordinating through phone and email with the MOS team. By 2012, Greenberg was running the workshops independently, and he is committed to continuing them as long as his REU programs continue. Success was validated through multiple overlapping evaluations, including ones administered by the UMass Donahue Institute, MOS, and the University of Wisconsin [3]. The Madison implementation has continued to produce strong results year after year, similar to those produced by the MOS team at the New England sites [2,3]. However, the Boston-to-Madison direct transfer dissemination method yielded just one new campus implementation over a two-year time-period, and it was difficult to assess whether Greenberg's success could be duplicated at other distant REU sites.

In 2011, the MOS team tried a second dissemination method, posting in the NISE Net online catalogue a comprehensive step-by-step REU SCW planning and implementation guide, including session outlines and materials, workshop leader scripts, PowerPoint slides, customizable hand-outs and evaluation tools [4]. However, the posting did not produce any known implementations, and the site design did not allow the NISE Net to track numbers of views nor downloads of the resource. By that time, the MOS team had also concluded that most potential workshop providers would want and need more personal implementation guidance.

The MOS team then looked into "Train-the-Trainer" dissemination approaches in which multiple potential providers are brought to a central location to be briefed on implementing a professional development workshop model. The "TTT" dissemination approach has a spotty track record since attendance at such a workshop does not guarantee that participants will gain sufficient confidence to return to their work site and implement the model on their own. So, in 2012, the MOS team, with NISE Net support, decided to test a new hybrid dissemination model. The concept was to graft or "piggyback" the TTT experience onto an actual implementation of the two-session workshop as normally provided by the MOS team during the course of an 8-12 week REU program. We hypothesized that the piggyback design - scaffolded with direct observation and participation in both workshop sessions, a take-home, step-by-step implementation guide, plus phone/email support - would yield better results than typical TTT workshop models. Indeed, this model yielded an instant 100% dissemination success rate. Each of the eight Implementation Workshop participants implemented the REU SCW at their home campuses in that same year, 2012. Within a single year, the MOS team had succeeded in transferring the model to eight new REU programs on seven additional campuses [3].

Since 2012, we have been concerned with two key validation questions: (1) Does the REU SCW produce successful results as implemented by the new providers at the "second wave" dissemination sites; and (2) Do the providers and stakeholders at these sites value the model enough to continue providing it?

APPROACH

The eight “second-wave” REU SCW providers agreed as a group to participate in a common set of survey and data-collection instruments and protocols throughout the implementation process in 2012 and 2013 and opted-in again in 2014. Student data collection was authorized by REU directors in accordance with IRB-approved protocols at each site and at MOS. The tools included pre- and post-session student surveys, final “end-of-program” surveys, provider surveys, faculty mentor surveys, and debrief conversations by phone. In 2012, data was collected in collaboration with the REU director at the University of Washington, using the University’s Catalyst WebQ online collection system. Since 2013 data has been collected at MOS using a licensed Fluid Survey system. Confidential student data collected at each site was aggregated, analyzed, and a summary report was returned to each REU director within a week of each collection period, in order to provide timely feedback and guidance to inform their ongoing implementation. (REU SCW sessions incorporate the reporting of aggregated student data to back to the students and guide them in making sense of their experience.) The Fluid Survey collection system also allowed the MOS investigators to aggregate student data from each campus to track findings and trends across the combined REU student cohorts. This report, therefore, focuses on data collected in 2013 and 2014.

Participants

Since 2006, 783 undergraduate research experience students have participated in the REU Science Communication professional development workshop: 395 in the workshops run by the MOS team in collaboration with REU directors at four universities in New England; 142 in the workshops run by the first direct dissemination site, the University of Wisconsin-Madison, and 246 at the eight university sites included in the 2012 multi-site dissemination effort. More than 16 REU directors and faculty and graduate student mentors have participated as facilitators.

Table I. REU SCW implementation and data collection sites with participant numbers.

*indicates programs provided directly by MOS team

| # Student Participants Undergraduate Research Program Sites | 2006-2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|--|---|-----------------------------------|------|------|--------------|---------------|
| MOS w/NSEC for High-rate Nanomanufacturing at Northeastern University , including students also placed at UMass-Lowell and U. New Hampshire | 92* | 31* | 38* | 22* | 13* | Center sunset |
| MOS w/NSEC + other REU programs at Harvard University School of Eng & Appl. Sciences | 103* | REU programs merger ended REU SCW | | | | |
| MOS w/Engineering (+ Co-Op in 2012) UG Research Programs, U. Massachusetts - Lowell | | | 15* | 54* | Discontinued | |
| NSEC; MRSEC; and various chem, bio, eng REU programs at U. Wisconsin-Madison | First dissem | 27* | 32 | 42 | 36 | 32 |
| Lurie Nanofabrication Facility/NNIN/ U. Michigan – Ann Arbor (C-PHOM included in 2014) | Dissemination sites added in 2012 (continued next page) | | | 10 | 11 | 10 |
| Institute for Electronics & Nanotechnology/NNIN/ Georgia Tech | | | | 8 | 6 | 8 |
| Center for Nanotechnology/NNIN/ U. Washington | | | | 6 | 7 | Staff lay-off |
| UCSB Nanofabrication Facility/NNIN/ UC-Santa Barbara | | | | 8 | 8 | 8 |

| | | | | | | |
|---|------------|------------|------------|------------|------------|----------------|
| Center of Integrated Nanomechanical Systems/NNIN / UC-Berkeley (COINS) | | | | 12 | 12 | 7 |
| Center for Energy Efficient Electronics Science / UC-Berkeley (E3S), plus SynBERC in 2013, plus TTE CC research experience students added in 2014 | | | | 9 | 15 | 25 |
| Engineering the Grid/ North Carolina State University | | | | 10 | 10 | End of program |
| TX Inst. of Intell. Bio-Nano Mat. & Struct. for Aerospace Vehicles (TiMS), AERO-U at Texas A&M | | | | 23 | 21 | 12 |
| Total REU SCW Participants | 195 | 58 | 85 | 204 | 139 | 102 |
| Cumulative REU SCW Participants 2006-2014 | 195 | 253 | 338 | 542 | 681 | 783 |

RESULTS

Research question #1: Does the REU SCW produce successful results as implemented by the new providers at the “second wave” dissemination sites?

We used four key indicators from the final end-of-program REU SCW student evaluation survey in 2014 to answer this question, and then looked back at 2013 data as well.

In 2014, six of the eight sites conducted their third year of implementation, and 59 of the 72 participants responded. The results (Table II) show that 80-90% specifically credited their participation in the REU SCW workshops with moderate to significant improvement in skills and confidence in communicating their research and the broader context and motivation for a research project (all key REU SCW objectives). In addition, 94% said either “yes” or “definitely yes” to the question “Should students in other undergraduate research programs be offered the opportunity to participate in a similar set of science communication workshops?”

Table II. Student participant responses from the six 2014 REU SCW second-wave sites.

How much have your science communication skills improved as a result of your participation in the science communication workshop sessions?

| Response | Chart | Percentage | Count |
|------------------------|-------|------------|-----------|
| No improvement | | 0.0% | 0 |
| Slightly improved | | 13.6% | 8 |
| Moderately improved | | 37.3% | 22 |
| Much improved | | 30.5% | 18 |
| Very much improved | | 18.6% | 11 |
| Total Responses | | | 59 |

How has your participation in the science communication workshop sessions affected your confidence in your ability to present your research?

| Response | Chart | Percentage | Count |
|--|-------|------------|-----------|
| I'm MUCH LESS confident than before | | 0.0% | 0 |
| I'm LESS confident than before | | 0.0% | 0 |
| I'm have the SAME confidence as before | | 20.3% | 12 |
| I'm MORE confident than before | | 62.7% | 37 |
| I'm MUCH MORE confident than before | | 16.9% | 10 |
| Total Responses | | | 59 |

Table II continues on the next page...

Table II, cont'd.

How has your ability to seek out and communicate the broader context and motivation for a research project improved as a result of your participation in the science communication workshop sessions?

| Response | Chart | Percentage | Count |
|------------------------|-------|------------|-----------|
| No improvement | | 1.7% | 1 |
| Slightly Improved | | 6.8% | 4 |
| Moderately Improved | | 30.5% | 18 |
| Much Improved | | 37.3% | 22 |
| Very Much Improved | | 23.7% | 14 |
| Total Responses | | | 59 |

Would you recommend that students in other undergraduate research programs be offered the opportunity to participate in a similar set of science communication workshops?

| Response | Chart | Percentage | Count |
|------------------------|-------|------------|-----------|
| No | | 1.7% | 1 |
| Not that important | | 5.1% | 3 |
| Yes | | 45.8% | 27 |
| Most Definitely | | 47.5% | 28 |
| Total Responses | | | 59 |

In 2013, when all eight second-wave sites were conducting their second year of REU SCW implementation, there were coordination problems with the end-of-program survey, and it was administered at only four of these sites, with 20 of those 31 students responding. As in 2014, these respondents specifically credited their participation in the REU SCW workshops with increasing their skills and confidence in communicating their research and the broader context and motivation for a research project. In addition, 90% said “yes” and “definitely yes” to the question whether they would “recommend that students in other REU programs be offered the opportunity to participate in a similar set of science communication workshops (Table III).

Table III. Student participant responses from four of eight 2013 REU SCW dissemination sites.

How much have your science communication skills improved as a result of your participation in the science communication workshop sessions?

| Response | Chart | Percentage | Count |
|------------------------|-------|------------|-----------|
| Not at all | | 5% | 1 |
| Not much | | 10% | 2 |
| Somewhat | | 10% | 2 |
| Moderately | | 60% | 12 |
| Very much | | 15% | 3 |
| Total Responses | | | 20 |

How has your participation in the science communication workshop sessions affected your confidence in your ability to present your research?

| Response | Chart | Percentage | Count |
|-------------------------------------|-------|------------|-----------|
| I'm MUCH LESS confident than before | | 0% | 0 |
| I'm LESS confident than before | | 0% | 0 |
| I'm ABOUT AS confident as before | | 15% | 3 |
| I'm MORE confident than before | | 70% | 14 |
| I'm MUCH MORE confident than before | | 15% | 3 |
| Total Responses | | | 20 |

Table III, cont'd.

How much has your ability to investigate and communicate the broader context and motivation for research improved as a result of your participation in the science communication workshop sessions?

| Response | Chart | Percentage | Count |
|------------------------|-------|------------|-----------|
| Not at all | | 0% | 0 |
| Not much | | 15% | 3 |
| Somewhat | | 20% | 4 |
| Moderately | | 35% | 7 |
| Very much | | 30% | 6 |
| Total Responses | | | 20 |

Would you recommend that students in other REU programs be offered the opportunity to participate in a similar set of science communication workshops?

| Response | Chart | Percentage | Count |
|------------------------|-------|------------|-----------|
| No | | 0% | 0 |
| Not that important | | 10% | 2 |
| Yes | | 70% | 14 |
| Most Definitely | | 20% | 4 |
| Total Responses | | | 20 |

Because of the lower site participation in the 2013 end-of-program survey, we also consulted the Post-SCW Session 2 Survey from that year, administered at all eight sites just after Session Two of the REU SCW with a higher response rate (71 of the 90 participants responded). This survey included one question identical to a question on the end-of-program survey, “How has your participation in this science communication workshop affected your confidence in your ability to present your research?” The responses to this question on the Post-SCW Session 2 Survey show a similar pattern of responses to the identical question on both the 2013 and 2014 final surveys.

Table IV. Comparison of confidence improvement ratings across 2013 and 2014 surveys.

How has your participation in the science communication workshop sessions affected your confidence in your ability to present your research?

| Response | 2013 Post-Session 2 Survey (8 sites) | | 2013 Final Survey (4 sites) | | 2014 Final Survey (6 sites) | |
|-------------------------------------|--------------------------------------|-----------|-----------------------------|-----------|-----------------------------|-----------|
| | Percentage | Count | Percentage | Count | Percentage | Count |
| I'm MUCH LESS confident than before | 0% | 0 | 0% | 0 | 0% | 0 |
| I'm LESS confident than before | 0% | 0 | 0% | 0 | 0% | 0 |
| I'm ABOUT AS confident as before | 24% | 16 | 15% | 3 | 20% | 12 |
| I'm MORE confident than before | 56% | 38 | 70% | 14 | 63% | 37 |
| I'm MUCH MORE confident than before | 21% | 14 | 15% | 3 | 17% | 10 |
| Total Responses | | 68 | | 20 | | 59 |

The Post-SCW Session 2 Surveys used across all eight sites in both 2013 and 2014 also included one other identical query asking respondents to rate the “usefulness of the inclusion of the science communication training in this research experience program. These responses reveal perhaps the strongest evidence that students valued the REU SCW highly, with 36 and 42% of students going beyond the “very useful” rating to the “especially useful” rating (Table V).

Table V. Student responses from all second-wave sites on the “Usefulness of the inclusion of the science communication training in this research experience program.”

| | 2013 | | 2014 | |
|--------------------------|------------|-----------|------------|-----------|
| | Percentage | Count | Percentage | Count |
| Not Useful | 0.0% | 0 | 0.0% | 0 |
| Slightly Useful | 5.8% | 4 | 6.7% | 3 |
| Moderately Useful | 21.7% | 15 | 11.1% | 5 |
| Very Useful | 36.2% | 25 | 40.0% | 18 |
| Especially Useful | 36.2% | 25 | 42.2% | 19 |
| Total Responses | | 69 | | 45 |

From these numbers, we conclude that the REU SCW implementations at the second-wave dissemination sites were valued highly by a large majority of students. Students recognized and reported substantial benefits from participating in the REU SCW. These data are similar to the findings reported previously from the MOS and Madison studies [2,3].

Research question #2: Do the providers and stakeholders at these sites value the model enough to continue providing it?

The REU directors all reported substantial positive impact from the REU SCW implementations. In response to a March 2014 email survey, all eight said that their implementation of the REU SCW had a positive impact on the students’ final slide and/or poster presentations, and seven of the eight indicated it was a “significant” or “very significant impact” [5]. Asked to further characterize the impact, the respondents mentioned “development of a clear and understandable presentation,” “inclusion of big picture into presentations,” “much more confidence in their presentation skills,” increased “level of comfort communicating science in front of a large audience;” and “clearer objectives for their careers.” One provider wrote, “No matter how many times we ask students to practice their presentation beforehand, they rarely do. But having to present at the workshop, gives them 2 opportunities (even if they are short) to speak in front of a group about their project, which makes their final presentation much stronger.”

Table I shows that, each year since launch, all nine REU SCW dissemination site providers (including Madison) have continued to implement the workshops and to participate in the joint data collection project, with only two “beyond-their-control” exceptions: the undergraduate research program at NC State ended with the 2013 cohort, and the University of Washington workshop provider was laid off after the 2013 implementation. As of November 2014, all REU SCW providers with continuing undergraduate research programs plan to continue implementing the workshop [6]. Some without a continuing REU program are applying their science communication training and facilitation skills in useful ways (e.g. the former University of Washington REU director is now coaching faculty in communication skills at Bellevue College). Two providers transitioning out of their roles as REU directors have each cultivated a successor provider to ensure continuation at their sites.

Most providers report hearing from REU faculty mentors that they have been happy with the results of the SCW, corroborating the very positive feedback the MOS team typically receives from faculty mentors at the New England sites, and what Andrew Greenberg reports from Madison. Faculty members who responded to mentor surveys administered in a few of the programs were in general pleased with their students' final posters and presentations and in some instances communicated relief that the REU directors were relieving them of the responsibility for this particular mentoring role. Many reported that students showed significant interest in exploring and understanding the broader context of the research.

Finally, there are indications of lateral dissemination at the sites. At Madison, REU SCW provider Andrew Greenberg now implements the REU SCW for several science and engineering REU programs on campus, and plans to continue to do so for the remaining two years of REU program funding. The two REU SCW providers from UC Berkeley joined forces to reach out to other on-campus REU programs each year, and now include all of Berkeley's five engineering REU programs. The University of Michigan provider recruited a new REU director to co-organize the 2014 workshops, adding in an additional REU program. Each REU SCW provider has also recruited and trained faculty and graduate student mentors to provide break-out group guidance during the workshop sessions.

In Boston, the MOS team has been invited to participate in three REU program proposals based on prior work with the Center for High-rate Nanomanufacturing and UMass-Lowell. Since August 2014, we've also begun to adapt portions of the REU SCW for use with undergraduate interns associated with new NSF Science-Technology Center for Integrated Quantum Materials (CIQM), which includes students from Howard University, Smith College, Wellesley College, Olin College, Prince George's Community College, and Gallaudet University. We've expanded work with graduate students and post-docs, building on the REU SCW format to create new workshop and coaching sessions for Harvard, MIT, and Howard graduate students associated with CIQM and the Research Laboratory for Electronics at MIT.

CONCLUSION AND DISCUSSION

The results indicate that the second-wave providers were able to reproduce the successful results achieved at the origination and first-dissemination sites, and that providers and stakeholders at the additional sites likewise value the model enough to continue providing it and in some cases to expand it laterally to other programs on campus.

Both dissemination methods - the direct, one-to-one transfer method and the piggyback, scaffolded Train-the Trainer method - have now been validated: they both produced successful student outcomes and resulted in enduring commitments among the providers. The success of the second method indicates that dissemination scale-up can now occur more quickly.

Perhaps more significantly we can now also confirm that the REU SCW model can be successfully adapted and implemented by a broad range of providers at a broad range of sites. It is indeed possible to empower undergraduate research experience program staff to provide the kind of quality science communication coaching locally that they might otherwise need to hire an outside contractor to provide, or do without. Local implementation is beneficial in many other ways, since it creates an ongoing community of practice among undergraduate research experience staff and faculty, and it allows for individualized mentoring and coaching over the course of the research experience.

Students clearly benefited from the experience provided by the participating program directors. In a longer paper, we can provide dozens of detailed written comments submitted by

students cataloguing the many ways that the REU SCW experience solidified their sense of accomplishment, deepened their research experience, and gave them the means to share that experience with peers, family, and community members who could continue to provide moral and material support for their STEM graduate school ambitions.

The community of practicing REU SCW implementers also contributed meaningfully to the iterative improvement of the REW SCW Planning & Implementation Guide [4]. With their reports and feedback, the Guide has been made more useful to a broader spectrum of undergraduate research experience providers and sites.

The findings suggest that it is possible to greatly expand the number of undergraduate research experience students receiving quality coaching in professional science communication skills by providing their program directors with a comprehensive professional development experience, employing the scaffolded, piggybacked, “beyond train-the-trainer” professional development model.

One final point: Now that we have a national network provider community and a partly-automated, unified, online survey system, it is possible to contemplate a program of longer-term multi-site data collection and aggregate analysis across multiple campuses. A study tracking potential longer-term impacts on REU SCW graduates now appears slightly more feasible.

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REFERENCES

1. The NSF Center for High-rate Nanomanufacturing at Northeastern, UMass-Lowell, and UNH, and the NSF Nanoscale Science and Engineering Center at Harvard, MIT, UCSB, and MOS.
2. C.L. Alpert, E. Levine, C. Barry, J. Isaacs, A. Fiorentino, K. Hollar, K. Thate, “Tackling Science Communication with REU Students: A Formative Evaluation of a Collaborative Approach,” *Materials Education*, ed. by M. Marinho Patterson, D. Dunham, E. Marshall, J. Nucci (Mater. Res. Soc. Symp. Proc. Vol. 1234, 2009), pp.04-12.
3. Alpert, C.L., “Beyond ‘Train-the-Trainer.’ A Preliminary Report on a New Scaffolding Strategy for Science Communication Workshop Dissem.,” *MRS Online Proc. Library* **1532** (2013).
4. Alpert, C.L., “REU Science Communication Workshop Planning & Implementation Guide,” NISE Network, 2011, revised 2014.
http://www.nisenet.org/catalog/tools_guides/reu_science_communication_workshop
5. March 2014 responses to email survey sent to all REU SCW providers.
6. November 2014 responses to email survey sent to all REU SCW providers.