A JOURNAL BY SISSA MEDIALAB

JCOM

PRACTICE INSIGHTS

Scientists' views about relationship-based science communication strategies

Nancy L. Staus, Julie Risien and Holly Cho

Abstract

Scientists are increasingly expected to share their research with the public using learner-centered strategies that build trust, such as engaging in relationship-building activities. A growing number of science communication training programs have been developed to address this need but little is known about whether and how scientists value such programs. In this paper we examine scientists' experiences with the STEM Ambassadors Program (STEMAP), a science communication training program that aims to build relationships for open-minded exchange between scientists and the public. We discuss benefits and challenges for scientists when using the STEMAP model for public outreach.

Keywords

Professionalism, professional development and training in science communication; Science communication: theory and models

Received: 31st May 2024
Accepted: 3rd December 2024
Published: 27th January 2025

1 ▪ Introduction

There has been a notable shift in how the scientific community views public engagement over the past few decades. While science outreach training historically focused on information transmission skills, substantial research on how people learn suggests that science communication needs to actively engage the public through learner-centered activities that account for the existing knowledge and interest of individual learners [National Academies of Sciences, Engineering and Medicine, 2018; National Research Council, 2009]. However, several analyses of science communication training programs suggested that many if not most training efforts continue to focus on knowledge transmission, positioning scientists as authorities whose responsibility is to explain scientific phenomena, rather than preparing them to meaningfully engage with members of the public with specific goals [Besley et al., 2015; Trench & Miller, 2012].

With increasing calls for more effective science communication practice, there is a growing number of training programs that seek to foster open dialogue and two-way exchanges with the public in order to build trust in science and scientists by giving the public a chance to meaningfully participate in discussions about science issues that affect their lives [McCallie et al., 2009]. However, there is little quantitative evidence of scientists' perspective of the value of such communication training [Besley et al., 2015]. Such knowledge is important because it could help identify what elements of training programs are perceived to be most useful and valuable for scientists and therefore may lead to long term changes in their science communication strategies. This information could then be used to develop and structure training and other kinds of support mechanisms in ways that fulfill perceived needs and that serve to attract more scientist participants, while supporting effective science communication with public audiences.

In order to better understand if and how scientists value science communication practices that focus on relationship-building rather than information transmission, this study examines scientists' experiences in the STEM Ambassador Program (STEMAP), a science communication as engagement training program for scientists that aims to help them build relationships with publics through open-minded exchange, particularly with members of the public who typically do not or cannot engage with science [Nadkarni et al., 2019]. STEMAP specifically focuses on helping scientists develop relationships with focal groups who share similar values and interests so public engagement activities are more likely to resonate with audiences' pre-existing values and beliefs. Our findings suggest that comprehensive training which incorporates relationship building with focal audience groups in order to design appropriate engagement activities was highly valued by participating scientists, connected to their personal and professional identities, and increased their confidence in participating in science outreach in the future.

2 ▪ Literature review

2.1 ▪ *Audience-centered science outreach*

Historically, science communication efforts emerged from a deficit perspective in which the underlying assumption was that a knowledge deficit was the reason for negative public attitudes toward science and associated inaction on political issues [Nisbet & Scheufele, 2009; Varner, 2014]. Thus, many scientists have approached outreach events from a transmission model in which scientists provide a unidirectional flow of information designed to educate and inform members of the public whom they believe have inadequate knowledge about science [Besley & Nisbet, 2013].

However, the deficit perspective does not align with what is known about how people learn science or form science attitudes or beliefs [Sturgis & Allum, 2004]. Substantial evidence suggests that greater knowledge has only a limited role in creating public perceptions and attitudes [Allum et al., 2008; Hungerford & Volk, 1990; Kollmuss & Agyeman, 2002]. In reality, public perception of science is more closely tied to individuals' culture, beliefs, and values which shape their interpretation and assimilation of scientific messages [National Academies of Sciences, Engineering and Medicine, 2016; National Research Council, 2009; Nisbet & Scheufele, 2009].

In addition to being ineffective for influencing science attitudes, top-down transmission models that situate scientists as authorities over a body of knowledge that the public does not understand can undermine public trust in science [Monroe, 2011]. This is particularly problematic when communicating about socially controversial topics such as climate change because scientific evidence that is contrary to one's worldview can be perceived as threatening to one's identity which can negatively affect engagement and learning outcomes [Bain et al., 2012; Sinatra et al., 2014]. However, evidence suggests that this effect can be reduced when scientists cultivate a relationship of trust with the audience by communicating shared values and fostering dialogue between scientists and the public [Goodwin & Dahlstrom, 2014; Kahan, 2015; Makri, 2017].

Despite the evidence that effective science communication needs to move beyond the transmission model to one of relationship building and encouraging open-minded exchange between scientists and the public, few outreach training programs for scientists focus on these elements [Stylinski et al., 2018]. Thus, there is little empirical evidence available to guide the development of more successful public engagement training that helps scientists connect and engage with public audiences, particularly those who do not typically seek out science activities.

Recently, several communication training programs have been developed that build on this social science evidence base by helping scientists engage in more effective communication strategies with public audiences. For example, the COMPASS program (formerly Communication Partnership for Science and the Sea) was developed to help scientists tailor outreach for specific audiences ranging from journalists to politicians to the general public [COMPASS Science Communication, Inc., 2017], by leading scientists through a process of distilling what they do and why it matters for a particular audience to achieve meaningful engagement with messages that resonate with specific audiences.

Similarly, Portal to the Public (PoP) was developed in 2007 to support the efforts of informal science education institutions to build programs that allow for face-to-face interactions between scientists and public audiences [Stylinski et al., 2018]. The PoP framework centered on enhancing scientists' two-way exchanges to support targeted learning outcomes and encourages scientists to engage directly with audiences, often through interactive hands-on activities to engage audiences in discovery-based learning. The more recent On the Spot Feedback Program extended this effort to provide scientists with tools that allow them to collect, reflect on, and respond to audience feedback in real time as they facilitate an engagement activity to provide learning experiences tailored to the interest and prior knowledge of their audience [Sickler & Lentzner, 2023].

However, a challenge with the above models of science communication is that for large heterogeneous public audiences, there is often a range of prior knowledge and interest making it difficult for the communicator to tailor their message effectively. For example, scientists at a radio astronomy facility that provides public tours often encountered audiences composed of individuals ranging from astronomy enthusiasts to curiosity seekers with little prior knowledge making it difficult to tailor their outreach to satisfy all visitors [Staus et al., n.d.]. A potential solution to this problem is to identify and develop relationships with target audiences who share certain interests and identities prior to engaging in outreach. Such a model is hypothesized to build trust and engagement by involving the audience in conversations based on shared values, goals, and identities [Appelman & Sundar, 2016; Fiske & Dupree, 2014; Mercer-Mapstone & Kuchel, 2015].

2.2 ▪ *Impact identity and relationship building*

Developing the relationships with public audiences that may lead to more effective science communication can be challenging for scientists who have had limited opportunities to connect and communicate with the public. Throughout their careers, many scientists engage almost exclusively in research and professional development activities within their scientific communities. Through this process, scientists develop a professional identity that differentiates them from non-scientists and may inhibit their ability to find alignment between their research efforts and public engagement with science [Tajfel, 1982; Tajfel & Turner, 1986]. Thus, an important part of developing relationships with public audiences is expanding this professional identity to include elements of one's personal identity such as preferences, skills, and values that are important parts of scientists' personal experiences. Together, these elements comprise an individual's impact identity which can be developed and cultivated in ways that allow scientists to identify and connect with public audiences who share similar interests and values [Risien & Storksdieck, 2018].

Recently there have been efforts to support scientists in developing their impact identity through training workshops as part of a larger focus on broader impacts which includes effective public communication and outreach activities [National Alliance for Broader Impacts, 2018]. Providers of this training posit that it allows scientists to explore options for impactful work in engaging the public in science that aligns with many dimensions of their identity and the contexts in which they live and work [Risien, 2017]. However, many scientists still struggle to access these resources, leaving them underprepared to develop the relationships that are necessary to connect with and meet the expectations of prospective public audiences.

2.3 ▪ *STEM Ambassador Program*

For this study we focus on the STEM Ambassador Program (STEMAP), a scientist communication as engagement training program that aims to help build relationships for open-minded exchange between scientists and the public, particularly those who do not or cannot engage with science. Funded by the National Science Foundation, the almost 10-year-old STEMAP uses an ambassador approach to connect scientists with public audiences, many of whom do not or cannot access science through traditional outlets, such as science centers or lecture halls [see Nadkarni et al., 2019, for a full description of the program]. This approach places science engagement activities into public venues in which people normally gather, rather than requiring individuals to travel to academic or science education locales. Thus, like government ambassadors, the scientist is effectively bridging the "nations" of science and society.

STEMAP is a multi-week program delivered as a series of five modules (connect, immerse, design, engage, and reflect) that leads participants through the process of designing and engaging in public outreach events. Participants are supported by STEMAP staff and peers throughout the program. The first two modules focus on relationship-building through connection and immersion. During the connection activities, participating scientists are first assisted in developing their impact identity (described above) by responding to a series of interview questions related to their research, personal interests, and experiences, and developing a personal impact identity statement. This process encourages scientists to expand their professional identities to be more inclusive of their personal values, interests and intentions for generating impact through their research, thereby inviting public audiences to engage in a more authentic way. Scientists are then guided in identifying focal groups with whom they share common interests, values, and experiences based on their impact identity statement. For example, a microbiologist with a personal interest in making kombucha identified a shared interest in the science of fermentation with cooking enthusiasts [Nadkarni et al., 2019].

During the immersion process, scientists develop relationships with their focal group through site visits and interactions with focal group members to learn more about the group's interests and to co-create ideas for outreach activities. For example, the microbiologist met with the instructor of the cooking school to better understand how to plan a fermentation course that would be of interest to participants. This relationship-building process is the cornerstone of the STEMAP program; only after this step do scientists design an activity and engage with the focal group to share research findings in ways that are interesting and relevant to the target audience. Here we document the experience of STEMAP participants with the relationship building process and how it affected their outreach experience, guided by the following research questions:

1. How did STEMAP participants perceive the value of building relationships with focal groups based on their impact identities?
2. What impact did STEMAP training have on scientists' confidence in engaging in outreach in the future?

3 ▪ Methods

3.1 ▪ *Participants*

The STEM Ambassador Program was offered to staff, faculty, post-doctoral scholars, and graduate students at three universities in the United States associated with the lead researchers on the project: University of Utah, Northern Kentucky University, and Oregon State University. Participants were recruited from all STEM departments at each university through the use of informational flyers that were emailed to department heads and posted

Table 1. Description of interview participants (n = 14).

Variable	n (%)
Gender	
Men	7 (50%)
Women	7 (50%)
Academic Role	
Faculty	5 (36%)
Graduate Student	5 (36%)
Post-doc	2 (14%)
Other	2 (14%)
Engagement event type	
Virtual*	9 (64%)
In-person	3 (21%)
None (was unable to schedule an event before interview)	2 (14%)

* Note that most engagement events were virtual because of the Covid-19 pandemic which limited the availability of in-person venues.

across campus. A total of 43 faculty and students participated in the STEM Ambassadors Program during 2020 and 2021, mostly from biology, chemistry, and engineering disciplines. At the end of the program, all participants who completed the program were sent email invitations to partake in interviews designed to understand their experiences in STEMAP and to learn more about the engagement events they planned and implemented. Fourteen STEM Ambassadors participated in interviews, including equal numbers of males and females (Table 1).

3.2 ▪ *Engagement events and focal groups*

Ambassadors planned and implemented a wide range of engagement events with diverse focal groups. While some ambassadors chose science-focused groups (e.g., a conservation organization focused on rivers, a local elementary school science classroom), many chose focal groups that were not necessarily interested or engaged in science (Table 2).

3.3 ▪ *Data collection and analysis*

Data were collected through semi-structured interviews that were conducted by two study team members (NS and HC) using a protocol specifically developed to explore STEM Ambassadors' experiences with the process of relationship-building prior to engaging in public outreach. Interviews lasted approximately 60 minutes and was guided by the following open-ended questions: "Tell me specifically about your experience with the relationship-building element of the STEM Ambassadors Program." "How did you go about the relationship building process?" "What was the most challenging aspect of this process?" "After your experience, what do you think about making relationship building a key element of public engagement?" "Do you feel more confident engaging in science outreach after participating in the STEM Ambassadors program?" These questions were used to generate conversations about participants' experiences in STEMAP, focusing particular attention on

Table 2. Description of focal groups and engagement events for each STEM Ambassador.

Ambassador	*Focal group*	*Description of Engagement Event*
1. Postdoc in biomedical engineering	Science fiction readers at a local bookstore	The ambassador chose a science fiction book that she had recently read and discussed different topics/passages in the book with the audience to examine whether each item was scientifically feasible.
2. Graduate student in entomology	Incarcerated youth in a juvenile detention center	Developed a virtual entomology lab tour where youth could engage with insects and learn about their importance in the ecosystem. He chose this focal group in part due to his Latino identity (many of the youth were Latina/o) and desire to support underserved youth.
3. Environmental studies faculty	Gardening enthusiasts at a county public library	Engaged in a presentation about gardening for biodiversity and rewilding your yard. The library had a garden area in which she could do a demonstration.
4. Health sciences librarian; 5. Graduate student in pharmacology	Support group for parents of children with disabilities	The ambassadors, one of whom was a new parent, and one a parent of a child with complex health issues, engaged the parents' group in the topic of accessing health information for children, free online databases for literature, and evaluation metrics used in health sciences to avoid misinformation.
6. Assistant Professor of Mathematics	Student government association	Shared algorithms from his research to help a campus student group solve a voting representation problem.
7. Paleo-oceanographer	Local environmental group	Provided information from her research about the natural history of the river system that would be useful for those working on current policy.
8. Environmental soil scientist	Local high school students	Developed an outreach program for high school students to promote soil science learning for diverse groups, especially underrepresented youth.
9. Biomedical engineer	Students in a juvenile detention center	Developed a virtual museum in Minecraft where students could prepare an exhibit of their choice.
10. Biomedical engineering graduate student; 11. Oncologist	Elementary school science students	Developed a science-art project on color, in which students painted with colorful bacteria on an auger plate and watched it grow.
12. Neuroscientist	Local foundation	Planned an event to help people with epilepsy understand how exercise can help them.
13. Nutritionist	Botanic garden	Provided nutrition classes focused on plant-based cooking.
14. Oncology graduate student	Breast cancer support group	Spoke about her research at one of the group's events.

the relationship-building process which is central to the STEMAP model of public science outreach.

Interviews were audio-recorded, transcribed, and analyzed using a content analysis approach [Cohen et al., 2007]. Data analysis took place in two stages, following an inductive coding approach that allowed themes to emerge organically from the data while remaining within the boundaries of our research questions.

During Stage 1, transcripts were read as a whole by the first author (NS), to capture initial impressions and to write research memos that reflected on potential emerging patterns

[Saldaña, 2015]. An inductive coding process was then used to identify preliminary themes directly from the data, guided by the research questions but without enforcing pre-existing frameworks. Initial coding identified primary themes such as the "value of relationship building" and "confidence/self-efficacy", aligning with key areas of focus in the interview protocol.

In Stage 2, the remaining team members (JR and HC) independently reviewed a subset of transcripts and cross-referenced preliminary codes to ensure alignment with the research questions. Matrix displays were created to visualize the occurrence of major themes across cases, facilitating the consensus-building process. The team then refined and consolidated the codes into a final version that captured the core themes and representative excerpts, enhancing the rigor and interpretive depth of the findings [Miles et al., 2014].

3.4 ▪ *Data confidentiality*

This research study was conducted in compliance with all ethical standards to ensure the confidentiality, privacy, and rights of participants. In alignment with these principles, data were collected, stored, and analyzed in a manner that safeguards participant identities and sensitive information. Participants were informed about the purpose of the study, their voluntary participation, and their right to withdraw at any time without consequence, and informed consent was obtained prior to data collection. This study received approval from the Institutional Review Board (IRB) at Oregon State University, confirming adherence to ethical guidelines for human subject research.

4 ▪ Results

4.1 ▪ *Value of relationship building*

To answer the first research question, we examined participants' views about the value of the relationship building process that is central to the STEMAP program. Our findings indicated that STEM ambassadors reported significant buy-in to the importance of relationship building in public science outreach. Nearly all (12/14) participants indicated explicitly that this element of STEMAP training was valuable to them, both personally and professionally. The value of building relationships with focal groups encompassed the following five themes: feelings of responsibility to the audience, connection with the public to build trust and humanize science and scientists, the personally and professionally rewarding aspects of building relationships with focal groups, outreach as a learning opportunity, and connections to personal and professional identities. These themes are described below and illustrated with representative text from the transcripts.

Feelings of responsibility to the audience. The majority of respondents (11/14) felt strongly that science is a public service and therefore scientists, especially those who are funded with public money, have a responsibility to engage in outreach to share their findings. Many felt a responsibility to be responsive to their chosen focal group, and worked closely with their focal group to develop outreach activities that were relevant for the specific audience:

> "Many scientists approach outreach with a one-size-fits-all approach. STEMAP showed that more directed approaches focusing on the needs and interests of the focal group have more impact." (Ambassador 1)

> "You need to tailor your message based on where the audience is from or what they're most interested in." (Ambassador 11)

However, not all focal groups were open to this new model of science outreach and some ambassadors experienced push back from audiences who were more comfortable with traditional presentation styles. For example, one ambassador worked with a high school and found that the science coaches and teachers did not want to mutually develop the science engagement activity:

> "The engagement idea was not mutually developed with the science coaches or teacher. They wanted the scientists to implement the idea they already had and the school would provide the audience." (Ambassador 10)

In addition, some non-traditional audiences such as incarcerated youth were not permitted to have direct contact with the ambassador, making co-creation of activities impossible.

Connection with the public to build trust. Because the project took place in the early phase of the Covid-19 pandemic, most engagement events were virtual. Consequently, many ambassadors struggled to make meaningful connections with their chosen focal group. Three participants described how relationship-building helped them create connections with their audiences that built trust and humanized scientists. This was especially important for participants who worked in areas of science with high levels of social controversy (e.g., climate change):

> "Relationship building is critical. It's the thing that builds the trust. It allows you to really make sure you are meeting people where they are and showing that you care to help with their understanding." (Ambassador 10)

> "Building positive relationships between scientists and the public can lead to positive feelings towards other science topics or science in general." (Ambassador 1)

> "Relationship building is our only chance; if we can't make connections we're doomed." (Ambassador 7)

However, two other ambassadors described the challenges to creating strong connections in virtual environments:

> "Virtual engagement is less robust than in-person. I could not develop close personal relationships with participants because of the virtual context of the engagement event." (Ambassador 4)

> "There was not a lot of interaction with the audience. My presentation took place on an online platform that didn't allow conversation although there were opportunities for written communication." (Ambassador 1)

An ambassador who engaged with incarcerated youth experienced similar challenges:

> "I didn't feel connected to the students. They all sat in a row in the back of the classroom which added additional distance between them and me, in addition to the virtual nature of the event." (Ambassador 2)

Personally and professionally rewarding. Three-quarters of respondents found the relationship-building process of STEMAP to be a rewarding experience that provided a lot of personal satisfaction:

> "Through the engagement event, I made connections with other groups that may lead to scientific collaborations." (Ambassador 7)

> "My engagement event brought me joy and a sense of worth." (Ambassador 4)

However, several reported that outreach is not necessarily valued by their academic institution, creating a tension between their desire to engage in more outreach and their professional obligations:

> "Outreach does not count toward promotion and tenure; I have to balance those activities with other professional obligations." (Ambassador 6)

Connections to personal and professional identities. About half of participants described how relationship building in STEMAP supported and connected to their personal and/or professional identities based on their impact identity assessment. Those that chose focal groups aligned with their personal (rather than professional) identities, were most likely to report on the importance of STEMAP in supporting their identities. They were also more likely to reach out to non-traditional focal groups. For example, Ambassador 2 identified as a Latino male which strongly influenced his choice of focal group:

> "My Latino identity helped with connection and communication with incarcerated youth who are disproportionately Latino. I could create a bridge to science for them."

Ambassador 5, a parent of a child with complex health issues, shared that they deliberately chose a focal group with whom they had a deep personal connection (parents of children with disabilities), which allowed them to connect the engagement event with both their personal and professional identities:

> "It was really rewarding to be able to connect aspects of my personal life as a new parent with my professional life [as a scientist]."

Outreach as learning opportunity. While not as common as other themes, several participants reported that building relationships with their focal groups led to additional opportunities for meaningful dialogue and reciprocal learning which would not be possible with more traditional transmission-style presentations:

> "With relationship-building, you learn from the focal group, you both learn from each other which is more rewarding than traditional presentations." (Ambassador 5)

> "And so I was really excited to kind of learn more from new parents and parents as part of that group." (Ambassador 4)

While nearly every participant we interviewed found value in the relationship-building process, they also reported that it was difficult to find time to engage in this model of outreach on a regular basis. As one participant shared:

> "I understand the value of the relationship building element, but it takes more time and energy investments than [traditional outreach]." (Ambassador 6)

4.2 ▪ *Confidence in engaging in outreach*

In order to address the second research question, we examined STEM ambassadors' confidence in engaging in public science outreach and how it changed through participation in STEMAP. Two themes emerged related to confidence. Many participants indicated an increase in confidence in conducting outreach after participating in STEMAP. However, because some ambassadors already engaged in substantial outreach, they did not feel that STEMAP made them more confident in conducting outreach, but they did report that they felt more confident that their outreach was effective.

Increased confidence in conducting outreach. Three quarters of respondents reported that participating in STEMAP training and conducting an outreach activity with their chosen focal group resulted in increased confidence in conducting outreach events. This was true even for scientists who had prior experience in delivering outreach. Some expressed more confidence in doing outreach itself:

> "I have greater confidence for engaging in outreach; STEMAP provided the tools and the methodological approach for engaging with the public." (Ambassador 9)

Increased confidence in conducting effective outreach. Others felt that they were already confident in doing outreach, but STEMAP helped them feel more confident that they could engage in effective outreach:

> "I don't feel more confident in doing outreach (already did a lot), but I do feel more confident in how I do it. I have more tools and more information to look for what's effective at learning." (Ambassador 10)

Additionally, some participants felt they had gained the confidence to approach other focal groups for outreach events in the future:

> "I have more confidence to approach other focal groups for similar projects." (Ambassador 3)

5 ▪ Discussion

We explored whether and how scientists value science communication practices that focus on relationship-building rather than information transmission. Our example, the STEM Ambassadors Program, centers on building relationships between public focal groups and scientists, introducing scientists to appropriate engagement tactics, and providing ongoing support as scientists practice new outreach skills with their chosen audience. Our findings demonstrate that, when trained and supported in public engagement strategies and activities, scientists are willing and able to develop relationships with public audiences and participate in two-way exchanges with the public. That is, almost all responding STEMAP scientists reported they valued this element of the training program and felt that it helped them better connect and build trust with public audiences.

Our analysis identified features of STEMAP that contributed to supporting scientists in the relationship building process with their chosen focal groups. In particular, participants' development of a personal statement based on their impact identity appeared to be a critical process for many ambassadors. By focusing on both their personal and professional identities inclusive of their personal values, interests and intentions for generating impact through their research, ambassadors were able to identify a variety of focal groups and develop pathways for connecting with them. Importantly, ambassadors focused on differing aspects of their identities with some emphasizing their professional identities as scientists and others incorporating elements of their personal identities such as their ethnic or parental identities. The latter was aligned with program goals related to humanizing scientists as actors with intersectional identities and affinities and enabling scientists to share their work as part of focal communities. While all participants used their impact identity to identify and connect with appropriate focal groups, ambassadors who focused on both personal and professional (rather than only professional) elements of their identities were more likely to seek out and engage with focal groups consisting of non-traditional science audiences, a major goal of STEMAP.

However, we also identified several challenges that scientists encountered that affected their ability to continue to engage in the STEMAP model of public outreach. For example, the STEMAP model is much more time intensive than traditional presentations as scientists must first identify a focal group, engage in immersion activities to learn more about them, develop relationships with the group and plan an engagement event that aligns with the needs and interests of the chosen audience. While nearly every participant we interviewed found value in that process, they also reported that it was difficult to find time to engage in this model of outreach on a regular basis. One ambassador concluded that he likely would not continue to use the STEMAP model in the future, but instead preferred to plan activities related to his research that he could share in classrooms. Although he was the only participant that indicated an intention to not continue with the STEMAP model, others voiced similar concerns regarding the time commitment and while some of the ambassadors had continued to interact with their original focal groups, none of those we interviewed had identified additional focal groups to develop relationships with or engaged in additional outreach activities.

Another challenge was the tension between participants' desires to meaningfully engage with a public audience and their professional obligations. As described earlier, several noted that engagement did not count towards promotion and tenure at their institutions and therefore were unsure if and how it would support them professionally. One ambassador reported that these conflicting goals prompted him to think about innovative ways to include engagement activities in his teaching such as including service learning components in some classes. This solution would allow him to continue to engage in outreach through an existing activity that is valued by his institution. However, other scientists may not have similar options suggesting that a systemic solution targeting structural issues in academia is needed. A recent overview of how university systems support scientists in their public engagement efforts highlighted the need for promotion and tenure reform to include outreach and engagement activities, but resistance at the institutional level remains pervasive [Risien & Nilson, 2018]. In reality, this will likely not happen until universities undergo structural reorganizations that formally recognize public engagement as critical to the institutions' missions.

Other potential challenges are associated with audience-related factors rather than the scientists' experiences. For example, not all audiences expect or value a presentation model that focuses on relationship-building and interactive communication strategies [Staus et al., n.d.; Merson et al., 2022]. In this study, there was evidence that some focal groups were not interested in building the types of relationships that are prioritized in the STEMAP model. For example, one ambassador reported that the school they worked with did not have the time or capacity to engage with scientists to co-develop presentations that met the needs and interests of their students. The schools preferred that the scientists implement a pre-planned presentation while the school provided the student audience. Although this experience was not the norm for our sample of STEM ambassadors, it is a potential challenge to keep in mind when engaging in science outreach that diverges from the traditional transmission model.

6 ▪ Conclusions and limitations

Our study highlights the potential benefits of incorporating audience relationship building into science outreach training programs. However, given the challenges with this process, particularly the time-intensive nature of developing these relationships, it may not be realistic to expect individual scientists to engage in the STEMAP model without some sort of continued support. One possibility is to establish STEMAP brokers at each participating institution who can help develop and maintain relationships with community groups (e.g., senior center, local hiking club) and act as a liaison between scientists and focal audiences. This would allow community groups to interact with a variety of different scientists over time and would make it easier for scientists to engage with numerous public audiences with different needs and interests.

The lack of institutional support for public science engagement efforts is more difficult to address and may ultimately make it difficult for research faculty to participate in STEMAP outreach. However, given the preponderance of graduate students, post-docs, and early-career participants in the STEMAP program, it might be possible to envision a different model in which public engagement training is included in doctoral programs, rather than targeting faculty members. Giving graduate students the tools and opportunities for engaging in relationship-based outreach may lead to future faculty who are able and willing to continue these efforts in spite of institutional challenges.

Acknowledgments

This study was supported by a grant (DRL-1906408) from the U.S. National Science Foundation.

References

Allum, N., Sturgis, P., Tabourazi, D., & Brunton-Smith, I. (2008). Science knowledge and attitudes across cultures: a meta-analysis. *Public Understanding of Science*, *17*(1), 35–54. https://doi.org/10.1177/0963662506070159

Appelman, A., & Sundar, S. S. (2016). Measuring message credibility: construction and validation of an exclusive scale. *Journalism & Mass Communication Quarterly*, *93*(1), 59–79. https://doi.org/10.1177/1077699015606057

Bain, P. G., Hornsey, M. J., Bongiorno, R., & Jeffries, C. (2012). Promoting pro-environmental action in climate change deniers. *Nature Climate Change*, *2*(8), 600–603. https://doi.org/10.1038/nclimate1532

Besley, J. C., Dudo, A., & Storksdieck, M. (2015). Scientists' views about communication training. *Journal of Research in Science Teaching*, *52*(2), 199–220. https://doi.org/10.1002/tea.21186

Besley, J. C., & Nisbet, M. (2013). How scientists view the public, the media and the political process. *Public Understanding of Science*, *22*(6), 644–659. https://doi.org/10.1177/0963662511418743

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. Routledge. https://doi.org/10.4324/9780203029053

COMPASS Science Communication, Inc. (2017). *The message box workbook*. https://www.compassscicomm.org

Fiske, S. T., & Dupree, C. (2014). Gaining trust as well as respect in communicating to motivated audiences about science topics. *Proceedings of the National Academy of Sciences*, *111*(supplement_4), 13593–13597. https://doi.org/10.1073/pnas.1317505111

Goodwin, J., & Dahlstrom, M. F. (2014). Communication strategies for earning trust in climate change debates. *WIREs Climate Change*, *5*(1), 151–160. https://doi.org/10.1002/wcc.262

Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. *The Journal of Environmental Education*, *21*(3), 8–21. https://doi.org/10.1080/00958964.1990.10753743

Kahan, D. M. (2015). Climate-science communication and the measurement problem. *Political Psychology*, *36*(S1), 1–43. https://doi.org/10.1111/pops.12244

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, *8*(3), 239–260. https://doi.org/10.1080/13504620220145401

Makri, A. (2017). Give the public the tools to trust scientists. *Nature*, *541*(7637), 261. https://doi.org/10.1038/541261a

McCallie, E., Bell, L., Lohwater, T., Falk, J. H., Lehr, J. L., Lewenstein, B. V., Needham, C., & Wiehe, B. (2009). *Many experts, many audiences: public engagement with science and informal science education. A CAISE Inquiry Group report*. Center for Advancement of Informal Science Education (CAISE). Washington, DC, U.S.A. https://informalscience.org/research/many-experts-many-audiences-public-engagement-science/

Mercer-Mapstone, L., & Kuchel, L. (2015). Teaching scientists to communicate: evidence-based assessment for undergraduate science education. *International Journal of Science Education*, *37*(10), 1613–1638. https://doi.org/10.1080/09500693.2015.1045959

Merson, M., Char, C., McFarland, M., Hristov, N. I., & Allen, L. C. (2022). Feeling accountable: interpreting park-based science in the 21st century. *Journal of Interpretation Research*, *27*(1), 5–24. https://doi.org/10.1177/10925872221084576

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: a methods sourcebook*. SAGE Publications.

Monroe, M. C. (2011). Engaging the public in environmental decisions: strategies for environmental education and communication. In H. Gökçekus, U. Türker & J. W. LaMoreaux (Eds.), *Survival and sustainability: environmental concerns in the 21st century* (pp. 741–749). Springer. https://doi.org/10.1007/978-3-540-95991-5_68

Nadkarni, N. M., Weber, C. Q., Goldman, S. V., Schatz, D. L., Allen, S., & Menlove, R. (2019). Beyond the deficit model: the ambassador approach to public engagement. *BioScience*, *69*(4), 305–313. https://doi.org/10.1093/biosci/biz018

National Academies of Sciences, Engineering and Medicine. (2016). *Science literacy: concepts, contexts, and consequences*. The National Academies Press. https://doi.org/10.17226/23595

National Academies of Sciences, Engineering and Medicine. (2018). *How people learn II: learners, contexts, and cultures*. The National Academies Press. https://doi.org/10.17226/24783

National Alliance for Broader Impacts. (2018). *The current state of broader impacts: advancing science and benefiting society*. https://www.broaderimpacts.net

National Research Council. (2009). *Learning science in informal environments: people, places, and pursuits*. The National Academies Press. https://doi.org/10.17226/12190

Nisbet, M. C., & Scheufele, D. A. (2009). What's next for science communication? Promising directions and lingering distractions. *American Journal of Botany*, *96*(10), 1767–1778. https://doi.org/10.3732/ajb.0900041

Risien, J. (2017). The national alliance for broader impacts. In B. E. Goldstein (Ed.), *Transformative learning networks: guidelines and insights for netweavers* (pp. 18–50). Network of STEM Education Centers. https://doi.org/10.31219/osf.io/94c27

Risien, J., & Nilson, R. (2018). *Landscape overview of university systems and people supporting scientists in their public engagement efforts: summary of existing recommendations and evidence from the field* [Report to the Kavli, Rita Allen, Packard, and Moore Foundations]. http://informalscience.org/support-systems-scientists-communication-and-engagement-exploration-people-and-institutions

Risien, J., & Storksdieck, M. (2018). Unveiling impact identities: a path for connecting science and society. *Integrative & Comparative Biology*, *58*, 58–66. https://doi.org/10.1093/icb/icy011

Saldaña, J. (2015). *The coding manual for qualitative researchers*. SAGE Publications.

Sickler, J., & Lentzner, M. (2023). *On-the-spot feedback: scientist experience. Summative evaluation report*. J. Sickler Consulting. https://doi.org/10.17605/OSF.IO/RTP4H

Sinatra, G. M., Broughton, S. H., & Lombardi, D. (2014). Emotions in science education. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International handbook of emotions in education* (pp. 415–436). Routledge.

Staus, N. L., Hoke, K., O'Connell, K., & Storksdieck, M. (n.d.). Visitor outcomes in response to audience-centered outreach by scientists [Manuscript in review].

Sturgis, P., & Allum, N. (2004). Science in society: re-evaluating the deficit model of public attitudes. *Public Understanding of Science*, *13*(1), 55–74. https://doi.org/10.1177/0963662504042690

Stylinski, C., Storksdieck, M., Canzoneri, N., Klein, E., & Johnson, A. (2018). Impacts of a comprehensive public engagement training and support program on scientists' outreach attitudes and practices. *International Journal of Science Education, Part B*, *8*(4), 340–354. https://doi.org/10.1080/21548455.2018.1506188

Tajfel, H. (1982). Social psychology of intergroup relations. *Annual Review of Psychology*, *33*, 1–39. https://doi.org/10.1146/annurev.ps.33.020182.000245

Tajfel, H., & Turner, J. C. (1986). The social identity theory of intergroup behavior. In S. Worchel & W. G. Austin (Eds.), *Psychology of intergroup relations* (pp. 7–24). Nelson Hall.

Trench, B., & Miller, S. (2012). Policies and practices in supporting scientists' public communication through training. *Science and Public Policy*, *39*(6), 722–731. https://doi.org/10.1093/scipol/scs090

Varner, J. (2014). Scientific outreach: toward effective public engagement with biological science. *BioScience*, *64*(4), 333–340. https://doi.org/10.1093/biosci/biu021

About the authors

Nancy Staus (Ph.D. Oregon State University) is a senior researcher at the STEM Research Center at OSU. Her research interests include STEM learning in informal science contexts, the role of emotion in science learning, and science communication.

stausn@oregonstate.edu

Julie Risien (Ph.D. Oregon State University) is Director of Transdisciplinary Research in the Division of Research and Innovation at OSU. Her research and practice center around advancing the impact is of research through partnerships and faculty professional development.

Julie.Risien@oregonstate.edu

Holly Cho (M.S. University of Wisconsin-Madison) is a researcher at the STEM Research Center at OSU. Her research interests focus on equity and inclusion in higher education, sense of belonging in STEM learning, and faculty professional development.

holly.cho@oregonstate.edu

How to cite

Staus, N. L., Risien, J. and Cho, H. (2025). 'Scientists' views about relationship-based science communication strategies'. *JCOM* 24(01), N03. https://doi.org/10.22323/2.24010803.